Engineering Record

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Waterworks Number

FOLLOWING the custom of former years, this issue of the Engineering Record, preceding the annual convention of the American Waterworks Association, which meets in New York next week, is devoted largely to waterworks articles. It contains a fund of information as diverse as it is valuable. Chief engineer, superintendent, chemist and bacteriologist, assistant engineer and construction man will all find something in the following pages directly applicable to his work. Asked for criticism of this journal's former waterworks numbers an engineer of wide experience said: "I have found your articles excellent, but the tendency is to give most of your space to the problems of the big, costly projects with which the small town engineer never has to deal. From the newspaper point of view this policy is, perhaps, justifiable, but it neglects a large class of men who want information on the small-scale undertakings—the jobs that are the day's work for them." In planning the contents of this issue this criticism proved decidedly helpful and an examination of the pages which follow will demonstrate that this year's waterworks number is essentially for the man in charge of small-town activities. It is not possible here to give a complete outline of the contents, but attention is invited to the articles on the new filtered gravity water supply for the village of Le Roy, N. Y.; the meter maintenance and repair system in operation at East Orange, N. J.; the saving of water in a 100-per cent metered city—Oak Park, Ill.; Diesel-engine pumping at Appleton, Wis., and comparative costs of sterilizing water with hypochlorite and liquid chlorine. These articles treat of work which is not out of the ordinary because of size, cost or special conditions. They are practical—for practical men.

Unjust Accusations

THAT the Thompson committee of the New York Legislature, which has for some time been attempting to discredit the Public Service Commission for the First District, in charge of the construction of New York City's new transit system, has outlived any usefulness it may have had, and has lately been reflecting more on its own ability than on that of the commission it is supposed to be discrediting, is admitted on all hands. However, when the committee persists, by means of statements and insinuations without foundation in fact, in attempting to misrepresent reputable members of the engineering profession, no matter how far below contempt the committee has brought itself, it is due to the engineers attacked to state publicly to the profession that the charges made and implied against them are baseless and without justification. Anyone who has read the public letter from Alfred Craven to the chairman of this committee, called forth by the insinuations of the committee's counsel while Mr. Craven was testifying before it, can appreciate the disagreeable situation in which, unfortunately, unscrupulous politicians have the power to place any man whom they attack. The attacks on Mr. Craven were entirely uncalled for. His life's record as an engineer, including his service with the commission, is a complete refutation of the slurs cast upon him.

Selling Water Efficiently

WHEN the taking of a bath is a recorded event—recorded on the meter chart of the main supply to a city of 31,000—water pipes are pretty tight. Even with such a record the officials of the water department of Oak Park, Ill., are still looking for leaks and do not profess to have reached the ideal. Incidentally there are no free services, so that consumers actually pay for the water wasted through leaky fixtures. In less than two years the night consumption has been reduced from 800,000 to 400,000 gal., and the bathtub story is not fiction. The superintendent has another halving of the night rate in mind as his goal.

The key to the method of administering the department, as outlined in the account on page 738 is the absolute control which the department officials have over the system. In the matter of "high-bill" complaints, no leniency is shown where charges are proved to be just, because it has been found that leniency encourages waste. Oak Park is a high-class residential suburb, and therefore it is comparatively easy to educate the citizens to the necessity of keeping fixtures in repair. In fact, they are educated to such an extent that they are coming to demand a better grade of work from the plumbers.

Another vital point in the water department's success is the backing given by the administration, which is, in effect, that of the city-manager form of government. Oak Park still adheres to the town system and the municipality is run as would be a business. The voters recently rejected the council-and-mayor form of government.

The contrast, in the matter of water consumption, between Oak Park and unmetered suburbs near Chicago is striking. But Oak Park has just as beautiful lawns and its citizens use just as much water legitimately as those of communities where the consumption is several times as great. Oak Park's record is a shining example of what can be done when the selling of water is put on a strictly commercial basis.

Architecture for Engineers

ENGINEERS who have occasion to design ornamental bridges or buildings must often realize their lack of preparation in even the simplest fundamentals of architectural design. Due to the prevailing tendency in engineering schools toward crowded curricula, containing highly specialized and differentiated technical courses, our educators have not provided broadening and helpful general courses in closely allied fields. One of the difficulties has been that the desired condensed courses are not offered by outside departments. For example, a course dealing with elementary principles and illustrated by interest-arousing examples taken from the student's own special field is requested from the department of architecture by the civil engineering department. Instead of such a course being created, the engineering students are often offered a piece of dead wood cut from a more extended course given to architectural students. The same is sometimes true of the courses given by the various departments of engineering to the students from other departments. Changes in engineering courses are of perennial interest and the advisability of providing a short course in architectural design for civil engineering students warrants the careful consideration of those responsible for curricula.

James J. Hill, Empire Builder

AS an empire builder, as a railroad operator and not as a "railroad magnate," as the Wall Street variety of railroad men are styled, the memory of James J. Hill will go down in American transportation history. With him the intrinsic worth of his properties and the prosperity of the communities they served were always of first importance. In this he stands out in striking contrast to those who consider railroads as pawns in the Wall Street game and to whose everlasting disgrace stand such wrecks as the New Haven, the Rock Island, the Frisco. A financial power undoubtedly he was—he had to be to care properly for his enormous interests. Primarily, however, he was a railroad man. The country generally well realized his worth—his contribution to the upbuilding of the "Hill" country. The Northwest, with good reason, revered him. Fortunately he has left behind him not only an example that will continue to inspire those who elect a railroad career but a generation of younger railroad men trained under him and in his methods, inspired by his ideals. His influence on American railroading will not soon wane.

The Subway Grating Again

LOUDNESS of protest and persistence of the protesters have scored a partial victory over the subway grating in New York City. On a recent decision of Commissioner Henry W. Hodge the Public Service Commission for the First District has decided not to build sidewalk ventilator gratings in front of the premises of lucky complainants on the uncompleted sections of the new dual system between Twenty-ninth and Thirty-fifth Streets and between Thirty-ninth and Forty-sixth Streets. From the announcement made by the commission it appears that forced mechanical draught and ventilator openings in parkways will be employed to change the air in these sections. It was found impossible to eliminate the gratings between Thirty-fifth and Thirty-ninth Streets. Although the plans for the change have not yet been made public, it is taken for granted that the changes contemplated maintenance costs to be borne by the entire city for the benefit of these property owners. Commissioner Hodge has stated that he does not believe that completed work should be ripped up merely for the purpose of removing the sidewalk gratings, and the only sections affected by the decision are those where gratings have not yet been constructed. A report, after a thorough investigation by an engineering commission of the entire question of ventilating the subways, which was abstracted on page 382 and discussed on page 376 of the Engineering Record for March 18, 1916, is upheld in the main by this decision. As was to be expected, the decision proved most unsatisfactory to the press of New York City, which is behind the property owners whose vault space has been encroached upon by the despised ventilator openings.

Catskill Aqueduct Progress

IN its annual report for the year 1915, soon to be published, the Board of Water Supply of the city of New York presents progress figures which support the prediction, made a year ago, that the great Catskill aqueduct system would be ready for actual service this year. The 1914 report, noted in an editorial in this journal July 17, 1915, page 65, recorded the fact that only two links in the 126-mile line between the Ashokan reservoir in the Catskills and the terminal reservoir at Silver Lake, Staten Island, remained unfinished—the Moodna supplementary tunnel and the Narrows submarine siphon. Of these the first is now completed, and at the end of 1915 only 250 ft. of the 10,620 ft. of 36-in. flexible joint submarine pipe across the Narrows remained to be laid. The best indication of the present status of the project, however, is the fact that in 1915 Catskill water was delivered from the Ashokan reservoir to points within the city limits for use in testing the north half of the city tunnel. As for the four reervoirs of the project—the Ashokan, Kensico, Hill View and Silver Lake—work was so far advanced at the beginning of this year that two were partially filled and one entirely filled with Catskill water. Construction on the Silver Lake reservoir was three-fourths finished. Hydrostatic tests of the city tunnel have shown a high degree of watertightness, although a few hundred feet of the line, where the rock backing was fissured, developed cracks, which are now being repaired. The total cash disbursements on the project at the end of 1915 amounted to $129,800,000, as against $123,000,000 reported for the previous year, while the force in the engineering bureau at the end of last year was reduced to 637. Among the important developments in 1915 was the securing of legislation governing the sanitary control of the Ashokan watershed and the selection of a definite site for the Schoharie dam, which will develop the second installment of 250,000,000 gal. of water daily. Added to the yield of the Esopus drainage area, which is now ready for delivery, this will bring the supply up to the aqueduct's capacity of 500,000,000 gal. daily.

Operating Cost of Motor Vehicles in Waterworks Service

TO THE ENGINEER who is contemplating the use of motor vehicles on work under his direction the all-important question is, "How much does it cost to operate an automobile?" Upon the answer much depends, for technical men appreciate that the automobile has a wider field of usefulness than mere pleasure riding. For road building supervision, for example, it is now conceded to be indispensable. In the case of a waterworks department it has not yet attained the same popularity, but the light, cheap car is demonstrating its value for such work as meter inspection and repair, collections, supervision of city pipe line construction and, in fact, all work which requires periodic visits by a department head or his deputies to distant points.

For data upon which to base his decision as to whether or not an automobile is a profitable investment the engineer has had to depend largely on the manufacturer's statement regarding the cost per mile for such items as gasoline, oil and tires. The automobile salesman, naturally, presents his case in its most favorable light, and while his figures may be entirely accurate, they may apply to performances under particularly favorable conditions. What the engineer wants is an unprejudiced summary of results actually secured under every-day conditions, and this he will find in Burt A. Heinly's article on page 728, telling of the performance of sixty-five motor vehicles in the service of the Los Angeles Water Department.

The data are valuable for they deal with a sufficient number of cars to give a dependable average and, what is equally important, they go into details. In studying these records, however, engineers in other cities should keep in mind, besides the usual local variations, two important points—that California's climate permits the use of motors the year round, and that the cost figures are based on the records of 1915, before the price of gasoline had soared to its present level. To arrive at reliable costs for present conditions elsewhere an allowance for these factors must be made.

Decolorization of Water

AT WILMINGTON, N. C., George F. Catlett, chemist in charge of the filtration plant, has recently put into successful practice some of the theories that have been discussed academically by sanitarians for several years. In particular he has done this by considering coagulation as a colloidal phenomenon. The water supply of Wilmington is taken from near the junction of two streams, one carrying colored water, one turbid water, and both of them tidal. The situation results in an extremely variable load on the filter from hour to hour, with a range of color in the raw water from about 130 to 200, and a range of turbidity from 0 to 50. This varying load coupled with a low alkalinity made the water a difficult one to decolorize. A coagulation basin of insufficient size increased the difficulty.

To obtain a good effluent and at the same time preserve a sufficient alkalinity to prevent rusty hot water in the city, soda was used with alum, and large quantities of both chemicals were applied. Present practice has been conducted on the theory that an excess of alkalinity should be maintained, but after some experimental studies Mr. Catlett found that a better decolorization, with smaller amounts of chemicals, was obtained by first overdosing the water with alum and afterward adding lime. This was a corroboration of the idea advanced by Prof. George C. Whipple many years ago in a discussion before the American Society of Civil Engineers, although the idea was worked out anew by Mr. Catlett.

A second coagulation basin constructed at Wilmington some time ago made it possible to put the idea into practice. The water in the first basin was kept acid, that is, was made to contain an excess of alum, and the alkalinity was restored as it entered the second basin. The result was a saving of 50 to 70 per cent in chemicals, and a filtered water clear and uniformly low in color. An incidental result of the overdosing with alum should be the prevention of algæ growths in the slightly acid water of the first basin. Detailed results will be found in the article on page 741.

Mr. Catlett's theory is that the coloring matter of water is a colloid charged with positive electricity, and that this charge is best neutralized by adding soda ash and alum together, with the latter in slight excess. The theory raises some interesting questions. The colloidal character of coloring matter may be regarded as established. But all coloring matter in water is not alike either in its appearance or in its re-action with chemicals. It is possible that not all of it is positively charged. Perhaps some coloring matter may be charged negatively. It is not certain, therefore, that the Wilmington method will work satisfactorily with all waters, but it is a method which should be studied experimentally wherever deeply stained water is being decolorized.

Mr. Catlett also advances the idea that carbonic acid acts negatively to the colloidal coloring matter and offers this as an explanation of the better keeping qualities of swamp water in casks on shipboard, the increased carbonic acid resulting from the decomposition of organic matter being an element in the subsequent clarification of the water.

If decolorization results from a neutralization of the positive electricity of colored colloids, one cannot help looking forward to some physical process which may perhaps accomplish this result without the use of alum, some process which will do for the colloidal coloring matter of water what the activated sludge process is doing for the colloidal matter of sewage. Defend it as we may, the use of alum for the decolorization of soft colored water has not been an unmixed blessing. Sometimes it of doubtful expediency. The Wilmington experiments point in a new direction and should be carefully studied.

Determination of Net Strains in Reinforced Concrete

ALTHOUGH there have been hundreds of strain measurements, on laboratory specimens and on actual concrete structures, for determining the stresses in reinforcing steel, generally with results that are consistent and apparently, therefore, reliable, there are two factors which are often neglected in the interpretation of these results. In the first place, shrinkage in the concrete has an influence on the deformation measured in that material, and the time element, as pointed out in the letters on page 652 of the issue of May 13, thus becomes of vital importance. Shall the strain measurements be made as the load is being applied or as it is being removed? What is the net strain which is the result of stress, and what value of the co-efficient of elasticity of the concrete should be used to translate strain into stress? These questions are pressing for answer, and the tests recently reported (see the Engineering Record of Feb. 26, pages 179 and 282, and of March 4, page 329) show that the subject is a live one and requires further exact experimentation.

In the second place, there must exist in the steel reinforcement an initial compression of unknown intensity, due to the shrinkage of concrete in setting. Although it is realized that there are practical difficulties, this journal suggests that in future measurements of strain the reinforcing rods be drilled with test holes before they are placed in the concrete. Accurate measurements and records of the unstrained lengths could thus be made and the amount of strain due to the effect of concrete shrinkage be determined. The presence of initial compression in reinforcement is, of course, advantageous for the tension steel in beams, but in columns it is an element of danger.

In any case, the exact determination of this factor would be a great aid in the attainment of a closer approximation to the true value of the internal stress in the material—which is the ultimate object of all such strain measurements.

Flaws in Road Bond Issues

THE FINANCING of road-building projects is bringing into the bond market an oversupply of county bond issues. There has been up to this time no marked reluctance to absorb these securities, but there are so many of them that the bankers are in a position to pick and choose as between those that are rated as being merely passable and those that are entirely acceptable. It cannot be expected that the supply of such issues can increase at the present rate without leading to a glut of the market and failure before the season is half over of many issues to find any market whatever.

State road bond issues are not here in question; there is little difficulty in ascertaining whether they are good or bad from an investment banker's point of view, whatever may be said from other viewpoints. Many miles of road for which a promise to pay in fifty years is outstanding, and on which interest must be paid for that length of time, have already worn out. The county bonds, of which so many are now coming on the investment market, are in a different category. As a rule, they run for twenty years, the security is ample and the credit of the communities that issue them is unquestionable.

Most of these issues, however, are the offspring of laws which authorize counties to bond themselves for all or a portion of the cost of highways, toward which the state or the abutting property owners or both may also contribute. The prescribed "legislation" leading up to the issuance of such bonds is often intricate. Its execution is left in the hands of county boards having the best of intentions but no experience in such matters and only a faint conception of how carefully a banker's attorneys will scrutinize the proceedings under which bonds are issued.

A middle western state, for example, has a law under which county road-building may be initiated upon petition of the property owners along the line of the proposed improvement. A certain proportion of the owners must sign the petition; then notice in certain form must be given of the date for a hearing, at which remonstrance against the movement may be made. Proceedings in the courts are authorized in certain instances to enable the commissioners to proceed in spite of remonstrances. If the project goes through, the state awards certain amounts per mile, depending on the classification of the road; the property owners pay 25 per cent of the remainder by installment assessments, and the county may issue bonds for the other 75 per cent.

If an insufficient number of property owners signed in the first instance, if there were unauthorized signatures on the petition, if there was any imperfection in the notice given of the proceedings of the county commissioners, or any flaw in carrying out any part of the page after page of detailed proceedings, the bonds may be declared invalid. Knowing this bankers are likely to regard such issues with suspicion without in any way questioning the credit of the county issuing the bonds. In many states entirely too much latitude has been allowed to counties in the matter of road-bond issues; or perhaps it would be more exact to say that they have put upon county boards duties and responsibilities which they are not equipped to perform. The casual assistance of a county attorney is often all the professional aid they have in carrying out proceedings quite as intricate and complicated as those for which the most competent legal talent would be employed if the case were, for example, that of a corporation making an issue of mortgage bonds. In such a case what will satisfy the banker's attorneys is ever in mind; while in the case of a county road-bond issue, that is not likely to be thought of until the banker refuses to consider the county's bond.

So far as the security back of county road bonds is concerned, the case is rare where the security is not much more than ample, even when, as should be done, no provision is made for retirement of the bonds in installments. There are few prosperous agricultural counties that are more than very lightly taxed in proportion to their wealth and ability to pay. Furthermore, when the cost of carrying a bond issue of say $1,000,000 is distributed per acre over the productive area of an average county the burden per acre or per farm is a mere feather weight. Such a computation made with respect of two Illinois counties showed that the interest and amortization charge per year on $1,000,000 of twenty-year bonds was less than 5 cents per acre. Not only is the charge light but the increase of property values is so substantial, and the saving in marketing so immediate, that the beneficiary of improved roads can pay for them out of a small share of what he derives from the investment.

This the bond buyer is usually willing to admit, but he nevertheless insists that the securities he buys must be entirely free from legal flaws. From this aspect the county road bond is likely to be weak. It is on this side, at least, that it needs strengthening in the opinion of the investment market. And, as pointed out in the beginning, the banker's requirements are likely to become more stringent and his scrutiny more severe as county road-bond issues multiply. This severity will become all the more marked as these securities get farther from home—out of the range of vision of the local banker—as they must, because no local market can absorb them in the quantities in which they are now coming forth.

Operating Cost Records Show Comparative Economy of 65 Motor Vehicles in Los Angeles Water Department

Analysis of Data Made for Machines Employed on General Administration, Meter Inspection, Collections and Pipe Line Construction and Repair—Blank Forms Developed and Maintenance Routine Systematized

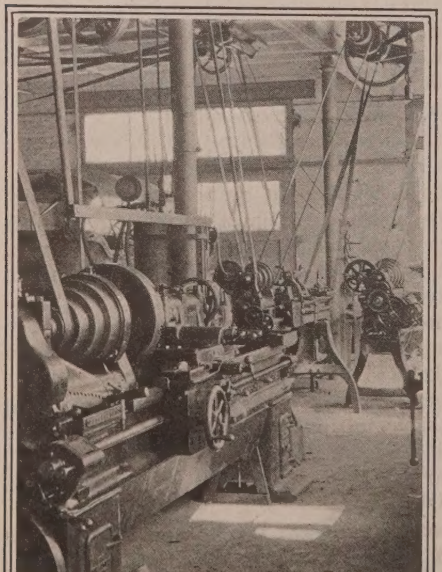
By BURT A. HEINLY
Bureau of Waterworks and Supply, Los Angeles, Cal.

BEGINNING with a five-passenger steam automobile in 1904, the Los Angeles City Water Department is now operating 80 self-propelled vehicles and has developed a system of operation and cost-keeping on standardized forms by means of which the performance of each machine may be accurately appraised. The methods employed are as simple, concise and lacking in red tape as it is possible to make them. The writer believes they are as applicable to the operation of 4 machines as 400. No delays, confusion or opposition of the force has been met with, and the cost is represented only by a small printer's bill and about one-half the time of one of the representatives of the purchasing department, who is known as the auto cost accountant.

In no other section of the United States are the conditions so nearly perfect for the use and development of the auto vehicle as in Southern California. This is due to the fact that in Los Angeles and adjoining counties a gentle climate makes the motor equally serviceable in all four seasons; the cities' streets are well paved and county roads, instead of following section lines, follow as a rule the trails of mission days, which pursue easy contour gradients. Improvement of the latter by state and county bond issues was begun seven years ago, and they are to-day among the best in the country.

YARD OPERATION

All cars are housed at the waterworks yards, centrally located. Room is here at a premium. To economize space, to make every car easily accessible and to procure a fireproof garage at a minimum cost, a 12-ft. brick wall was built along the boundary line of the property. This provides the side of the storage shed. Sheet steel roofing supported on steel posts completes the building, a part of which is shown in the illustration. In a less kindly climate a frontage of lift or sliding doors would be required.



MACHINE SHOP FOR AUTO REPAIRS AT LOS ANGELES IS COMPLETELY EQUIPPED

Each car is given and is known by a number and has its assigned place in the shed. The gates of the yard close at sundown and every car, with the exception of three or four for the use of executives who are subject to night call, must be reported in before closing time. Reporting-in consists of driving up to the filling stand where the keeper reads the speedometer and fills the machine with oil and gas. This information is set down on form C, which the driver endorses; it is then dropped into a locked mail box to which there is only one key—that of the cost accountant. Filling at night prevents any delay in getting away from the yards promptly on time in the morning and the method of accounting for gas and lubricant and checking against the filling of the garage tanks, as well as the speedometer readings, guards against the use of these commodities on private or any other vehicles than those of the department.

Two washers, one at $3 per day and one at $2.50 per day, are on an 8-hr. shift at night for cleaning the cars. If any car needs repairs it is laid out for the repair shop and an extra is made ready and is used until the regular car is again ready for the road.

All regular cars are driven by their users with the exception of the chief electrical engineer and the chief water engineer, who have drivers at $85 per month. All work cars are driven by the gang foreman. Truck drivers on light hauling do their own unloading, but on heavy trucking they are given helpers.

GARAGE MACHINE SHOP

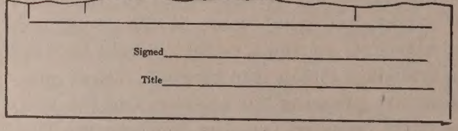
For the maintenance of equipment the two-story brick stables in 1912 were converted into a garage, the lower floor being given over to completely equipped machine and blacksmith shops; what was the haymow now serves for a paint and woodworking shop. An oxy-acetylene cutting and welding outfit, recently installed, is one of the largest time and money savers with which the shop is supplied. The force comprises a foreman at $5 per day and four assistants at $4 per day, with an emergency chauffeur at $90 per month who does about one-half shop time.

The shop in equipment is prepared to assemble completely any car, do all necessary woodworking and smithy work and all but the finer grades of painting. In addition, it serves as the mechanical aid of all outside construction camps and does all the mechanical and repair work for a distribution waterworks system of over 1000 miles. Hours of labor in the shop are from 7.30 a. m. to 4:30 p. m., the machines getting away from 7.30 to 8.00 a. m.

On entering the shop in the morning each mechanic receives his day's shop work card, form B, on which he keeps the record of his time and the material used. These on the morning following are collected by the auto cost accountant. The payroll is made up from this form, so that the cost keeper's record in both material and labor is checked. The form is simple and self-explanatory. All tire labor goes on form B and the tire data are recorded on form C. This has become a very important item for watchfulness, and great care is urged that no tire changes, whether on the road or in the shop, shall be made without a full record being taken. All auto equipment and the mechanical force are under the personal direction of the assistant superintendent, whose office is at the yards and whose hours are such that he is at his point of duty when the cars leave in the morning and when they return at night.

PURCHASES

All machines except Fords, which are purchased by simple resolution of the Board of Commissioners, are bought under sealed bids. This is required by law and is not entirely satisfactory. It results too often in acceptance of the lowest responsible bid, as is also by law required. To-day prices of machines are stabilized and matters of public knowledge. To purchase by make, disregarding in a measure the first price and giving consideration to operating costs, would tend to better the system. The specifications are drawn as broadly as possible in order that bids on almost any make of vehicle may be submitted. In these, two requirements are of merit: One is that the car must be of a model and make of common use in the city, with a bona fide agency where repair parts are kept on hand, and the other that the bidder shall furnish as a part of his bid a complete list of parts with prices. All trucks are purchased without bodies. These are manufactured in the department's shop along lines best adapted to waterworks use and at a cost of about 40



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No. ....

DEPARTMENT OF PUBLIC SERVICE

REQUISITION FOR SUPPLIES

Dated.......................191....

To the PURCHASING AGENT of the Bureau of Water Works and Supply of the City of Los Angeles:

The following articles as shown below are required for use at

Ship to ______________

Quantity	ARTICLES

Signed______________

Title______________

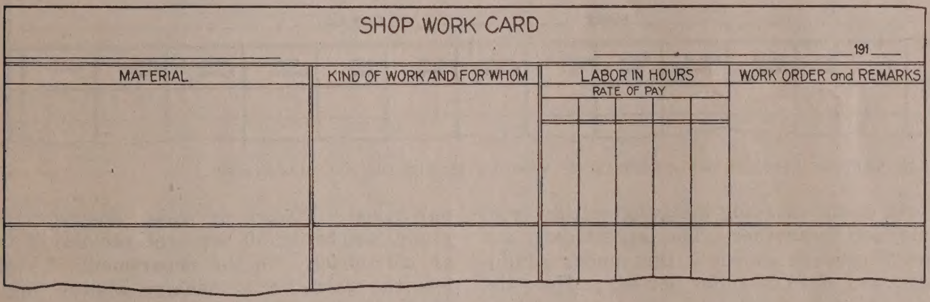
FORM A—REQUISITION FOR SUPPLIES

per cent less than they can be purchased for elsewhere.

All equipment, such as parts, tires, etc., are purchased through the purchasing department, of which the auto cost accountant is a member. He handles the larger part of auto purchases and is greatly assisted in this by his first-hand knowledge of the quality and durability of the materials he buys. The shop foreman in making his orders uses form A—requisition for supplies. Where possible repair parts and supplies are purchased in quantities, the department having agreements with most of the dealers by which it receives regular dealer rates. A requisition in quadruplicate is then made out, one copy being retained by the purchasing department, one going to the auditor, one to the seller and one to the shop foreman. Payment is refused on goods obtained by any other than this method.

OFFICE RECORDS

Once each day the daily auto service report (form C) and the shopwork cards (form B) are collected by the auto cost accountant. From these the day's data for each machine are placed on the daily automobile record (form 1), which is spaced and dated to show the complete performance of a car for one month. The capitulation of form 1 goes onto the monthly automobile record (form 3), which contains spaces to show the complete equipment of the car and the capitulation of which gives the total cost of the machine to the department for the year.



SHOP WORK CARD

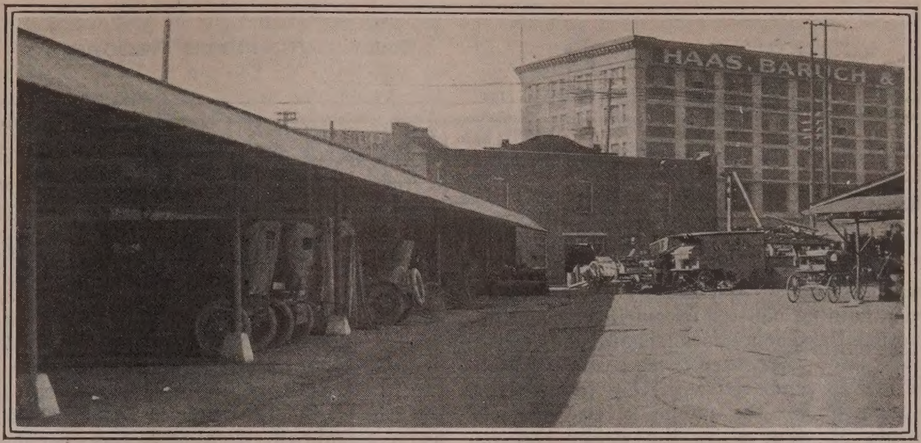
191__

MATERIAL	KIND OF WORK AND FOR WHOM	LABOR IN HOURS RATE OF PAY	WORK ORDER and REMARKS

FORM B—SHOP WORK CARD COLLECTED DAILY BY AUTO COST ACCOUNTANT

Tire mileage record (form 2) gives the complete history of every tire owned by the department from the time purchased until it is worn out or replaced for inferiority. The three forms outlined above and here illustrated are of such simplicity that no further explanation is required. It is only needful to add that forms 1, 2 and 3 are cut for a loose-leaf ledger so that they form a single volume which is filed at the end of the year.

Some criticism may be made that the records are not as complete as should be necessary. To this answer can be made that the department has found the records sufficiently complete for all practical purposes. Eighteen months ago it was decided that neither the department's forms nor its tabulated records were of sufficient detail. It therefore assigned the auto cost accountant, on leave of absence, to make a study of the methods employed by all the larger private enterprises of this section that were using auto equipment. He found much more elaborate and involved systems than that here shown, but they brought complaint from drivers and much clerical work in tabulation. From his study and the department's needs the old system was revised, improved and adopted as here shown.



BECAUSE OF MILD CLIMATE THE STORAGE SHEDS FOR THE LOS ANGELES WATER DEPARTMENT AUTOMOBILES DID NOT REQUIRE OUTER WALLS

It has thus far developed no serious defects and we begin our second year under it without any change.

Costs for the 65 vehicles during 1915 were kept by one man, the auto cost accountant, who devotes approximately one-half his time to this work, the remainder being taken up with his regular duties in the purchasing department.

TIRE RECORDS

Outside of the value of knowing just what the equipment and each driver of a machine is doing, the cost-keeping for autos has produced a saving sufficient to defray about one-half the cost accountant's salary in the matter of tires alone. Before a careful record was kept there was no means of knowing what the tires were doing. All tires are under a guaranty of 3500 miles, with replacement at cost proportional to the mileage run. Many times, under the old system, no demand on the tire agent was ever made; there was nothing to rely upon but the driver's memory and it was much easier for the foreman to slip on a new tire at regular cost than to waste time in trying to fight it out with the agent for a replacement. To-day a defective tire goes back to the agent with its slip showing the whole record of its use and failure and there is no discussion over a refund. Moreover, it appears that nearly all makes of tires are subject at some time or other to periods of poor material or manufacture. The tire records show whenever and wherever this period arrives. With reports on tires of one make in use on three or four cars showing a falling off in mileage as compared with previous records or with records of other makes, the brand is discontinued and purchases are not resumed until information is obtained from other users that it has returned to its original standard. Where purchases in a year aggregate $6500 this is an item that will bear watching.

At the end of the year a sheet giving the year's run of each car, as shown in the table, but less perfect in form, is made up and each driver is furnished with a copy. The writer believes that much good could be accomplished by doing this monthly, thus creating a spirit of rivalry in securing the largest mileage at the least operating cost. The attention of drivers has been called at various times to the high mileage costs they were running up and warnings have been given, but the system has never extended beyond this point.

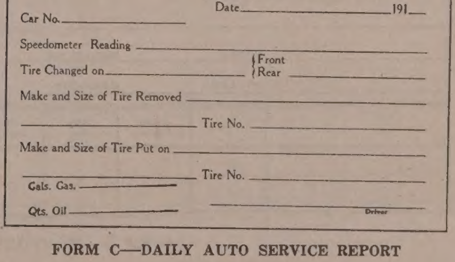
Consulting the table, original costs of cars and accessories will be found higher than in the Eastern states, owing to the addition of freight rates. Gasoline, however, is cheaper because Los Angeles is in the producing field. For this item the city purchases for all departments under an annual contract which is let in July. For the first six months of 1915 the contract price was 12 cents per gallon; during the last six months the price was 9½ cents per gallon, although on Jan. 1, 1916, garage prices had raised to 18 cents per gallon. The department's consumption of this commodity is about 300 gallons per day.

For its choice of lubricants the department, two years ago, conducted a durability test, resulting in the selection of a lubricant of standard make. This is purchased of a medium grade in 50-bbl. lots, delivered as needed, at 45 cents per gallon, less 10 per cent when the whole order has been completed. The quantity of oil used is about 1 bbl. per week.

For truck tires, the department has practically standardized on Goodyear S. V. Pressed-on. Where heavy loads are carried, the rear tires used are 5-in. dual solid and on small trucks 5-in. single solid.

WHAT THE TABULATION TELLS

The figures as presented by the table comprise a frank, unvarnished statement



Form 20—10m-11-15-15

DEPARTMENT OF PUBLIC SERVICE
BUREAU OF
WATER WORKS AND SUPPLY

DAILY AUTO SERVICE REPORT

Date__________191__

Car No.__________

Speedometer Reading __________

Tire Changed on__________ Front / Rear __________

Make and Size of Tire Removed __________

__________ Tire No. __________

Make and Size of Tire Put on __________

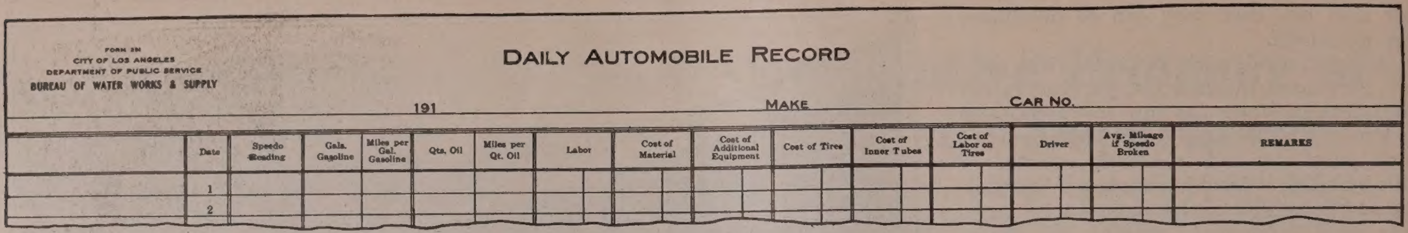
__________ Tire No. __________

Gals. Gas. __________

Qts. Oil __________

__________ Driver

FORM C—DAILY AUTO SERVICE REPORT



FORM [illegible]
CITY OF LOS ANGELES
DEPARTMENT OF PUBLIC SERVICE
BUREAU OF WATER WORKS & SUPPLY

DAILY AUTOMOBILE RECORD

191 MAKE CAR NO.

	Date	Speedo Reading	Gals. Gasoline	Miles per Gal. Gasoline	Qts. Oil	Miles per Qt. Oil	Labor	Cost of Material	Cost of Additional Equipment	Cost of Tires	Cost of Inner Tubes	Cost of Labor on Tires	Driver	Avg. Mileage if Speedo Broken	REMARKS
	1														
	2														

FORM 1—THE DAY'S INFORMATION FOR EACH MACHINE IS ENTERED UNDER THESE HEADINGS

of operating costs, carefully compiled and with nothing omitted except interest on investment and depreciation charges, of which more later. Whether these costs are high or low as compared with the operation of equipment by the public service departments of other cities the writer has not been able to ascertain, as he has been unable to find published data with which a comparison could be made. With data printed as advertisement for several factories the Los Angeles mileage costs, it is freely admitted, will show high, but the writer can only believe that these records were not made so inclusive as his own, or else they were under ideal, and not practical, working conditions. In any event the mileage costs as shown in the table are about the average of what the department will continue to pay, as the operation of the equipment is now on a thoroughly organized basis.

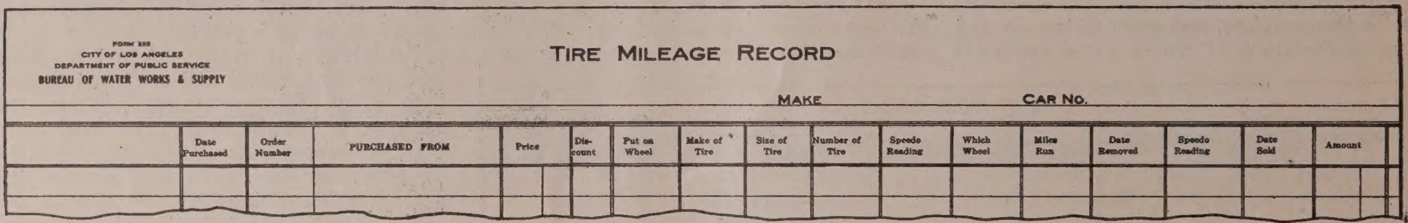
From the standpoint of the tables one thing is certain—the operation of an auto vehicle by a public utility or a private business is only comparatively cheap. In the question of cost there can no longer be ground for comparison between it and the horse, for the horse is to-day in limbo.

Service Classifications

To arrive at costs of different classifications of service the cars were arranged under four different heads. For administration the average cost per car per day amounted to $1.44. As there are 21 cars so listed, the transportation cost for this item (which includes cars not particularly for administration but difficult to list under any other head) amounted to $30.32 per day. Cars for collections cost 66 cents per day for each machine, or $3.96 per day for the 6 in service. For the meter department the cost was $1.10 per car per day or $22 per day for the 20 machines this branch of the service requires. For the pipe-laying department the cost per vehicle was $1.346 per day or $24.23 as a total daily cost for the 18 machines required. Motorcycles for linemen on the Los Angeles aqueduct telephone patrol cost a total of 75 cents per day or 37½ cents for each machine. This makes a grand total expense to the department of $81.26 per day for the movement of its men and supplies. Comparing this sum, however, with the cost of horse equipment as used to the same end, it is safe to say that the latter could only be operated, and with much less efficiency, at two or three times the amount.

Low daily mileage may cause comment. This must be expected in a public service utility where the auto is used largely for hauling the men and light material to the work or for carrying the gang quickly from one job to another. The largest daily average mileage shown is that under administration at 31.26 miles per day. Here the auto is a money saver in an unexpected way. By enabling a chief executive to visit four or five important works at least once and often two or three times each day it has conspired against the engineer of only average ability. For him has been substituted the day foreman who is thoroughly capable provided he is not called upon for initiative and can be constantly observed and his efforts properly directed. The auto in this way has undoubtedly enlarged the field of the chief executive engineer and narrowed the scope of the engineer of lesser ability who, with collegiate training, reluctantly, if at all, accepts the foreman position and the foreman pay. There is, of course, the further saving alluded to by other writers in the centralization at one point under one executive head of all men and equipment.

In the compilation a depreciation charge has not been added to the operating cost, nor are any overhead charges accounted for. In figuring depreciation no hard and fast rules can be followed. It will vary with each car, depending upon the carefulness of the driver, the whole number of cars and the judgment of the man setting the depreciation rate. The time of service for a machine can therefore give no adequate basis for the actual working value of the car. As an instance of this, a Buick, 1914 model, driven by the farm superintendent, has deteriorated more than 60 per cent in less than two years because of hard usage, whereas a Kissel-Kar, model 1913, bought October, 1912, but driven by a mechanic who understands his machine, has gone a great many more thousand miles, and, as far as working parts are concerned, is in practically as good condition as when it was purchased. Placed on sale, however, it might not bring 50 per cent because it is an old model. To the department it still has the value of a machine almost new. Moreover, with the simplification and improvement of the modern car of to-day, particularly the motor truck, and in a business where style or appearance is of very little importance, the serviceable life of a machine is still a very debatable question. We are little interested, therefore, in figuring depreciation costs, but we are interested in figuring what cars make the miles with the least expenditure of tires, oil and gas.



FORM [illegible]
CITY OF LOS ANGELES
DEPARTMENT OF PUBLIC SERVICE
BUREAU OF WATER WORKS & SUPPLY

TIRE MILEAGE RECORD

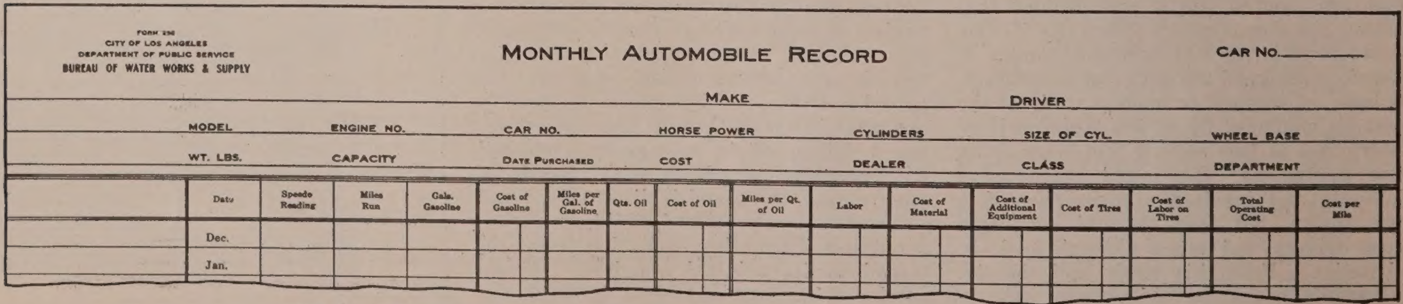
MAKE CAR NO.

	Date Purchased	Order Number	PURCHASED FROM	Price	Discount	Put on Wheel	Make of Tire	Size of Tire	Number of Tire	Speedo Reading	Which Wheel	Miles Run	Date Removed	Speedo Reading	Date Sold	Amount

FORM 2—A DETAILED RECORD IS KEPT OF THE SERVICE OF TIRES OF VARIOUS MAKES ON ALL MACHINES

The advent at the opening of 1915 of a moderately priced light truck worm-driven and with the engine under the hood has met with much satisfaction. It has long been the belief of Assistant Superintendent Brooks that this would be the final form evolved for trucks of this character.

The department has standardized on no special make of car. One reason for this, as referred to under "purchases," is that



FORM [illegible]
CITY OF LOS ANGELES
DEPARTMENT OF PUBLIC SERVICE
BUREAU OF WATER WORKS & SUPPLY

MONTHLY AUTOMOBILE RECORD

CAR NO.

MAKE DRIVER

MODEL ENGINE NO. CAR NO. HORSE POWER CYLINDERS SIZE OF CYL. WHEEL BASE

WT. LBS. CAPACITY DATE PURCHASED COST DEALER CLASS DEPARTMENT

	Date	Speedo Reading	Miles Run	Gals. Gasoline	Cost of Gasoline	Miles per Gal. of Gasoline	Qts. Oil	Cost of Oil	Miles per Qt. of Oil	Labor	Cost of Material	Cost of Additional Equipment	Cost of Tires	Cost of Labor on Tires	Total Operating Cost	Cost per Mile
	Dec.															
	Jan.															

FORM 3—MONTHLY AUTOMOBILE RECORD WHICH IS A CAPITULATION OF DATA ON FORM 1

the city charter requires the acceptance of the lowest responsible bid and this has resulted in an array of cars of different makes. The efficiency of the department's auto service makes it desirable to a dealer, from his selling standpoint, to say that the department has his make in its service and in order to place his car he is willing to make reductions to insure his being low bidder. As this is written the department is purchasing four 2½-ton trucks for $8,800, this price being 18 per cent under the bidder's established rate for the trucks in question. Even so, his was not the low bid, and the low bidder threatened injunction pro-

OPERATION AND MAINTENANCE COST OF MOTOR VEHICLE EQUIPMENT, LOS ANGELES WATER WORKS, IN 1915

Car Number and Make	Model	A.L.A.M. Rating	Date Purchased	Cost	Use	Miles Run	Gallons Gasoline	Cost Gasoline	Quarts Oil	Cost Oil	Labor	Cost Material	Cost Added Equipment	Cost Tires	Labor on Tires	Total Operating Expense	Miles per Gallon Gasoline	Miles per Quart Oil	Total Cost per Mile	No. Months Run	Weight
I. *Administration*																					
5 P. Alco	1912	60.0	3-29-12	$3500	Chief El. Eng.	11,688	1240	$149.03	393	$46.68	$125.55	$285.30	......	$522.13	$9.30	$1137.99	9.425	29.740	$0.0973	12	4500
5 P. Ford	1915	22.5	2-16-15	*525	Owens River Work	10,352	669	116.13	130.5	18.88	50.45	127.18	......	160.24	.50	473.38	15.473	79.325	.0457	11	1475
5 P. Ford	1915	22.5	2-24-15	*525	Supt.ofsmallsystem	6,965	509	56.64	86.5	9.75	79.15	94.34	......	73.28	2.05	315.21	13.683	80.520	.0452	11	1475
5 P. Ford	1915	22.5	4-15-15	565	Surveys	10,428	708	73.12	78	8.84	30.15	55.58	......	55.25	2.70	225.64	14.728	133.690	.0216	9	1475
5 P. Ford	1915	22.5	9- 8-15	493	Asst. El. Eng.	3,656	286	27.39	43	4.66	44.40	90.59	81.50	34.30	.75	283.59	12.761	85.020	.0776	4	1475
5 P. Olds	1915	30.0	8-25-15	1225	Asst. El. Eng.	3,957	285	28.61	15.5	1.73	2.15	30.11	......	23.45	.....	86.05	13.884	255.290	.0218	5	2700
5 P. Kissel Kar	1913	28.9	10-20-12	3150	Asst. Supt.	15,983	1439	153.96	408.5	46.69	128.40	271.27	......	228.17	5.45	833.94	11.110	39.126	.0522	12	3150
5 P. Kissel Kar	1913	28.9	10-20-12	3150	Chief. Mech. Eng.	12,805	1033	111.15	392	44.52	127.70	208.49	......	190.77	2.40	685.03	12.395	32.666	.0535	12	3150
5 P. Ford	1913	22.5	10- 7-13	675	Field Eng.	16,575	1069	114.16	272.5	31.17	147.80	314.08	......	144.89	1.80	753.90	15.505	60.286	.0455	12	....
2 P. Ford	1913	22.5	10- 7-13	575	Timekeeper	15,140	865	92.41	114.5	12.97	83.57	91.10	......	86.58	2.55	369.18	17.503	132.227	.0244	12	1475
5 P. Pierce Arrow	1912	38.4	10-16-13	2500	Chief Eng.	16,402	1887	204.64	162.5	19.05	83.60	247.76	......	400.53	.80	956.38	8.694	100.935	.0583	12	3770
5 P. Pope-Hartford	1913	36.1	10-16-13	1400	Aq. Supt.	13,509	1067	160.31	208	32.06	337.20	533.34	......	444.59	4.50	1,512.00	12.666	64.899	.1119	12	4650
3 P. Mitchell	1910	28.9	......	......	Chief Mech. Con.	3,024	231	27.72	55	6.60	10.10	3.20	......	37.75	.65	86.02	13.091	54.981	.0218	4	2725
2 P. Olds	1915	30	5-25-15	1285	Chief Mech. Con.	12,210	682	70.15	60	6.92	25.70	17.01	......	62.43	3.23	185.44	17,916	201.818	.0152	8	2600
5 P. Franklin	1912	38.4	......	......	Extra Car	13,313	1330	166.19	147	18.83	256.45	261.30	......	317.43	1.30	1,021.50	10.013	90.874	.0767	12	3475
2 P. Buick	1914	22.5	4-22-14	1060	Farm Supt.	9,985	717	153.61	260	37.65	130.00	199.01	......	162.40	5.50	688.17	13.926	38.403	.0689	12	2155
5 P. Dodge	1915	25	5- 2-15	975	Asst. Aud.	9,871	631	67.17	136	15.17	29.30	35.13	......	71.10	2.35	220.82	15.655	72.531	.0224	8	....
5 P. Ford	1915	22.5	5-15-15	525	Bacteriologist	7,593	565	59.37	62	7.06	19.90	40.58	......	37.45	.50	164.86	13.427	122.468	.0217	8	....
2 P. Ford	1915	22.5	9-18-15	525	Gager	3,456	234	36.55	35	4.68	21.85	9.15	19.72	27.50	.....	119.45	14.737	98.743	.0346	4	1475
2 P. Dodge	1915	25	11-27-15	895	Meter Supt.	852	62	5.95	5	.50	4.85	14.15	......	12.69	.25	38.39	13.632	170.400	.0451	1	....
2 P. Mitchell	1909	25.6	12-15-08	1900	Meter Supt.	3,826	232	25.24	68	7.98	47.35	29.53	......	42.72	1.00	153.82	16.491	56.264	.0402	11	2550
Total	..	..	......	$25,448	....	201,590	15741	$1899.50	3132.5	$382.90	$1785.62	$2958.20	$101.22	$3135.65	$47.58	$10310.76	286.715	2000.256	$1.0016	..	....
Av. for 21 cars	..	..	......	1339.31	....	9,599	749.5	90.52	149.6	18.23	85.03	140.86	4.82	149.31	2.08	443.36	12.806	64.3	.0477	..	....
Av. cost per day, 307 days	..	..	......	......	....	31.26	2.44	.295	.48	.059	.276	.458	0.15	.487	.006	1.444	.....	......	.....	..	....
II. *Collections*																					
2 P. Ford	1911	22.5	7-1 11	$575	Collector	12,951	818	$89.80	151	$17.80	$117.55	$102.64	......	$99.77	$3.20	$430.76	15.842	85.768	.0333	12	....
2 P. Ford	1915	22.5	6-28-15	443	Collector	3,012	232	22.42	37	4.16	7.56	2.90	......	....	.....	37.04	12.954	85.405	.0122	5	....
2 P. Ford	1913	22.5	6-28-13	575	Collector	6,034	434	41.56	50	5.55	8.60	18.18	......	20.50	.....	94.39	13.919	121.899	.0156	7	....
2 P. Ford	1915	22.5	9- 1-15	443	Collector	2,235	164	15.58	34	3.61	40.17	20.25	8.57	....	.75	88.95	13.628	64.782	.0398	4	....
2 P. Ford	1915	22.5	8-28-15	443	Collector	2,082	158	14.96	15	1.68	12.85	5.25	9.90	....	.....	44.64	13.219	138.800	.0215	5	....
2 P. Ford	1915	22.5	11- 1-15	443	Collector	1,498	119	11.26	15	1.50	3.00	3.84	11.21	....	.....	30.81	12.641	99.866	.0206	2	....
Total	..	..	......	$2922	....	27,812	1925	$195.58	302	$34.30	$189.73	$153.06	$29.70	$120.27	$3.95	$1157.35	82.203	596.520	.1130	..	....
Av. for 6 cars	..	..	......	487	....	4,635	321	32.59	50	5.71	31.62	25.61	4.95	20.04	.66	192.89	14.45	.92	.0238	..	....
Av. cost per day, 307 days	..	..	......	......	....	10.09	1.04	.106	.16	.132	.103	.084	.016	.66	.002	.635	.....	......	.....	..	....
III. *Meter and Service Trucks and Work Cars*																					
Ford Work Car	1915	22.5	7- 7-15	443	Leaks	6,553	489	$46.42	43.5	$4.67	$21.88	$11.37	$8.65	$48.52	.....	$141.51	13.373	150.184	$.0216	6	1450
Ford Work Car	1915	22.5	5-28-15	443	Extra	4,908	281	27.85	33.5	3.75	20.75	13.17	7.81	....	......	73.33	17.466	146.507	.0149	7	1450
1½ Ton Autocar	1911	18	9-12-10	2350	Leaks	10,781	1320	143.12	338.5	39.45	230.08	307.63	......	93.43	3.70	817.41	8.167	31.849	.0758	12	4300
1½ Ton Autocar	1911	18	5-25-11	2350	Leaks	9,756	1336	145.47	279.5	32.33	138.65	189.59	......	71.23	1.25	578.52	7.302	34.901	.0593	12	4300
1½ Ton Autocar	1911	18	7- 8-11	2350	Services	7,842	926	99.68	161	18.50	70.65	145.68	......	171.67	1.65	507.83	8.473	48.708	.0648	12	4300
1½ Ton Autocar	1911	18	8-29-11	2350	Cement	6,737	1219	132.09	257	29.71	86.55	93.09	......	119.21	2.20	462.85	5.526	26.214	.0687	12	4300
1½ Ton Autocar	1912	18	6-25-12	2300	Services	6,804	928	99.00	265	32.74	91.05	141.47	......	56.20	1.70	422.16	7.332	25.679	.0620	12	4300
1½ Ton Autocar	1915	18	5- 8-15	1750	Leaks	7,311	975	99.30	200	22.16	77.13	16.54	36.01	....	.....	251.14	7.494	36.555	.0344	8	4300
1½ Ton Autocar	1915	18	7-17-15	1745	Services	4,242	525	49.99	123	13.24	92.88	11.00	92.70	62.05	.....	321.86	8.072	34.488	.0759	5	4300
1½ Ton Autocar	1915	18	7-22-15	1745	Leaks	7,593	816	77.49	164	17.56	119.93	28.92	122.97	....	.....	366.87	9.299	46.298	.0483	6	4300
1½ Ton Autocar	1915	18	8-25-15	1745	Services	2,288	350	34.09	35	3.70	55.65	21.67	23.20	37.50	.....	175.81	6.537	65.371	.0768	5	4300
1½ Ton Federal	1915	18	2-19-15	2000	Meter and Serv.	4,344	796	85.64	93.5	10.83	288.70	459.52	46.01	31.60	.50	922.80	5.461	46.459	.2103	10	4500
2 Ton Kissel Kar	1913	32.4	9-23-13	2325	Meter and Serv.	7,528	1306	139.60	306	35.74	31.90	89.84	......	69.36	.....	366.44	5.762	24.601	.0485	12	6225
Ford Work Car	1914	22.5	7-27-14	575	Meter Insp.	12,512	644	68.04	138	15.80	24.25	46.72	......	71.63	1.70	228.14	19.429	90.666	.0182	12	1450
Ford Work Car	1914	22.5	7-27-14	575	Meter Insp.	13,133	876	95.66	125	14.31	52.55	86.86	......	93.58	3.00	345.96	15.001	105.888	.0263	12	1450
Ford Work Car	1915	22.5	3-15-15	443	Meter Insp.	10,903	817	85.56	82	9.53	41.75	21.14	7.01	63.99	.....	288.98	13.337	132.158	.0210	10	1450
Ford Work Car	1915	22.5	3-15-15	443	Meter Insp.	10,788	759	79.34	81	9.26	45.08	23.54	7.01	74.52	.25	239.00	14.204	133.185	.0222	10	1450
Ford Work Car	1915	22.5	9- 7-15	443	Meter Insp.	4,640	377	35.78	27	2.83	17.70	8.45	14.31	6.50	.....	85.57	12.324	175.094	.0184	4	1450
Ford Work Car	1915	22.5	10-19-15	443	Meter Insp.	2,808	208	19.86	35	3.50	14.90	5.10	13.93	....	.....	57.29	13.467	80.229	.0204	3	1450
Ford Work Car	1911	22.5	6-21-11	590	Shop Car	3,249	269	29.02	21	2.40	21.15	32.69	......	9.60	.....	94.86	12.100	154.714	.0292	12	1450
Total	..	..	......	$27408	....	144,720	15,127	$1593.00	2808.50	$322.01	$1543.18	$1753.99	$379.61	$1080.59	$15.95	$6748.33	210.126	1589.748	$1.0170	..	....
Av. cost for 20 cars	..	..	......	1370.40	....	7,236	761	79.65	140.4	16.10	77.15	87.69	18.98	54.02	.79	337.41	9.51	51.05	.0508	..	....
Av. cost per day, 307 days	..	..	......	......	....	23.56	2.47	.227	.45	.05	.25	.285	.0616	.176	.002	1.10	.....	......	.....	..	....
IV. *Pipe Laying, Heavy and Work Trucks*																					
1½ Ton Autocar	1911	18	5-25-11	$2350	Extra	8,001	1051	$114.89	189	$21.58	$63.45	$160.55	......	$102.91	$1.70	$465.08	7.609	42.333	$.0581	12	2350
1½ Ton Autocar	1912	18	6-25-12	2300	Extra	7,008	947	102.23	209	26.24	65.50	67.73	......	125.04	.50	387.24	7.404	33.531	.0553	12	2350
1½ Ton Autocar*	1913	18	2- 4-13	2300	Pipe Const.	10,433	1434	156.25	289	33.44	98.00	106.58	......	129.24	.....	523.51	7.275	36.100	.0502	12	2350
1½ Ton Signal	1915	20	4-20-15	1710	Pipe Const.	6,513	1289	129.22	88	9.92	72.60	17.64	......	46.01	.....	275.39	5.051	74.011	.0423	8	....
1½ Ton Federal	1915	18	7-31-15	2000	Pipe Const.	3,163	424	40.21	21	2.26	62.59	16.39	94.28	....	.....	215.73	7.460	150.619	.0682	5	....
3 Ton Packard	1912	32.4	11-15-11	3600	Hauling Pipe	11,863	2178	231.32	727	83.20	61.00	131.98	......	354.74	.95	863.19	5.448	16.329	.0728	12	8175
2 Ton Moore	1912	32.4	4-19-12	2670	Pipe Const.	6,637	1177	126.35	236	27.04	155.25	62.27	......	120.04	2.80	493.75	5.641	28.122	.0744	12	7350
2 Ton Moore	1914	32.4	4-24-14	2351	Pipe Const.	6,389	1291	139.35	196	23.15	108.81	115.79	......	201.95	.....	589.05	4.946	32.514	.0919	12	7335
2 Ton Moreland	1913	27.2	6-30-13	2343	Pipe Const.	6,817	935	101.55	203	23.56	88.15	78.06	......	175.62	1.25	469.19	7.294	33.581	.0688	12	6160
3 Ton Mack	1913	48.4	6-25-12	3250	Hauling Pipe	12,755	3044	330.31	1169	135.24	160.49	96.61	......	240.08	5.30	976.03	4.190	10.911	.0765	12	9100
½ Ton Regal	1909	25.6	7-17-09	2300	Pipe Const.	5,099	620	68.31	257	29.82	43.75	51.83	......	61.24	1.85	256.80	8.231	19.840	.0504	12	1350
½ Ton StoddardDayt'n	1908	27.2	2-23-10	600	Gate Insp.	11,557	1116	120.08	140	15.62	79.30	68.47	......	132.90	.90	417.27	10.355	82.550	.0361	12	3240
¾ Ton Kissel Kar	1912	28.9	4- 9-12	1459	Pipe Const.	7,933	1000	108.40	331	40.28	75.87	110.74	......	135.65	2.10	473.04	7.953	23.966	.0596	12	3650
¾ Ton Kissel Kar	1912	28.9	6-25-12	1650	....	7,913	1044	115.00	380	44.28	93.75	120.04	......	120.20	2.45	495.72	7.580	20.323	.0626	12	3650
½ Ton Mitchell	1910	28.9	6- 1-13	700	Gate Rep.	9,006	907	96.92	418	47.41	97.53	55.35	......	125.03	1.60	423.84	9.9229	21.519	.0491	12	3150
½ Ton Stoddard Dayton	1908	28.9	7-17-15	*	Gate Rep.	.....	66	6.27	18	2.08	2.80	16.26	......	27.41	.....	....	.....	......	.....	..	....
Ford Work Car	1915	22.5	3-15-15	443	Pipe Const.	3,987	381	39.11	67	7.60	21.87	13.58	7.01	14.54	.50	104.21	10.228	58.164	.0267	10	2350
Ford Work Truck	1915	22.5	7-17-15	443	General	5,660	351	33.55	45	4.96	21.23	12.83	8.12	23.95	.25	104.69	16.125	125.777	.0185	6	....
Ford Work Truck	1915	22.5	4-26-15	443	Irrigation	14,802	952	103.12	183	20.32	51.15	41.84	7.01	91.90	1.85	317.19	15.548	80.805	.0214	9	....
Total	..	..	......	$32912	....	145,536	20207	$2162.44	5166	$598.00	$1432.09	$1344.54	$116.92	$2228.45	24.00	$7850.92	148.261	891.995	$.9809	..	....
Av. cost for 18 cars	..	..	......	1732.21	....	7,660	1063	113.81	272	31.47	75.37	70.76	6.15	117.28	1.26	413.20	7.2	28.11	.0516	..	....
Av. cost per day	..	..	......	......	....	24.9	3.46	.37	.88	.102	.245	.23	.02	.382	.004	1.346	.....	......	.....	..	....
V. *Motorcycles*																					
Merkel	1913	..	9-24-13	......	Telep. Line Rider	2,440	66	$7.15	28	$3.18	$8.40	$43.10	......	$12.09	.....	$74.73	37.880	87.142	$.0304	12	....
Merkel	1914	..	6-24-14	......	Telep. Line Rider	10,223	158	19.03	60	6.92	27.50	88.97	......	13.02	.....	155.44	64.933	170.383	.0152	12	....
Total	..	..	......	......	....	12,663	224	$26.18	88	$10.10	$35.90	$132.07	......	$25.11	.....	$230.17	102.813	257.525	$.0456	..	....
Av. cost per car	..	..	......	......	....	6,331	112	13.09	44	5.05	17.95	66.03	......	12.55	.....	115.08	56.53	144.0	.0228	..	....
Av. cost per day	..	..	......	......	....	20.6	.36	.423	.14	.016	.584	.218	......	.04	.....	.374	(51.4)	(128.76)	.....	..	....
Grand Total																					
Total	..	..	......	$88790	....	532,319	53314	5876.70	11497	1347.40	4986.52	6341.86	626.95	6590.07	91.48	26297.53	829.281	5335.544	3.1881	..	....
Av. cost per vehicle	..	..	......	1409*	....	7,945	796	87.71	171.5	20.11	74.42	94.65	9.35	98.36	1.36	392.50	9.98	79.63	.0476	..	....
Av. cost per day	..	..	......	......	....	25.88	2.59	.285	.55	.065	.242	.308	.03	.32	.004	1.278	112.377	......	.....	..	....

*Av. for 63 cars.

ceedings to force the purchase of his car. In this instance the table here illustrated was brought forward and the respective merits of not only the equipment but the operating costs set forth.

The refusal to standardize, however, has had certain advantages, one being that it maintains competition not only on initial costs of machines but also on parts. Be this as it may, the department has come to look upon two machines as almost standard. The writer has no fear of being accused of publicity work in mentioning the Ford. Unquestionably it is by all odds the car best adapted to department service under the three main heads of initial cost, cheapness of maintenance and cost of operation. The department has 26 in use. If out of service they are easily repaired at low cost of parts and little time is required in the shop for parts replacement. The operating costs in the table speak for themselves. On collection service, where they are the only machines employed, the operation in 1915 ranged from 1½ to 3 1-3 cents per mile (downtown streets, with traffic stops and low gear frequent), while the average daily cost was only 63½ cents, or less than half the daily maintenance of a one-horse rig.

On Ford light work-cars, which the department does not hesitate to load to 1000 lb., the turtle-back end of the roadster is removed and is replaced by a light truck body built at the shop at a cost of from $7.50 to $8 each. Several such trucks have been in use since 1911 and they are still "running strong."

ONE TRUCK PARTLY STANDARDIZED

Consulting the table, the reader will be able to denominate the truck that has been partially selected as standard. This is for the reason that, like the Ford, its factory has standardized the model, many of the parts are interchangeable and these are sold at a reasonable price. If not overloaded it is of good value in waterworks service. In very hilly regions, on account of its small horsepower, the machine might not prove serviceable, but here, with comparatively gentle gradients, the engine is of large enough size to do the work assigned to it, is of sufficient speed and the truck is not torn to pieces by too much engine.

The department does all its own hauling with the exception of cast-iron pipe from cars to trench. This is let by annual contract and comprises usually the disposition at one time of several thousand tons arriving in quantities which the department could not handle without disrupting its regular auto service, and then with heavy railroad demurrage.

In the hauling of gates, hydrants and stock pipe no effort has been made in the tables to arrive at ton-mile costs. The needs of the different gangs are so variable, with small and diminishing loads so frequent, that cost data would be of little value.

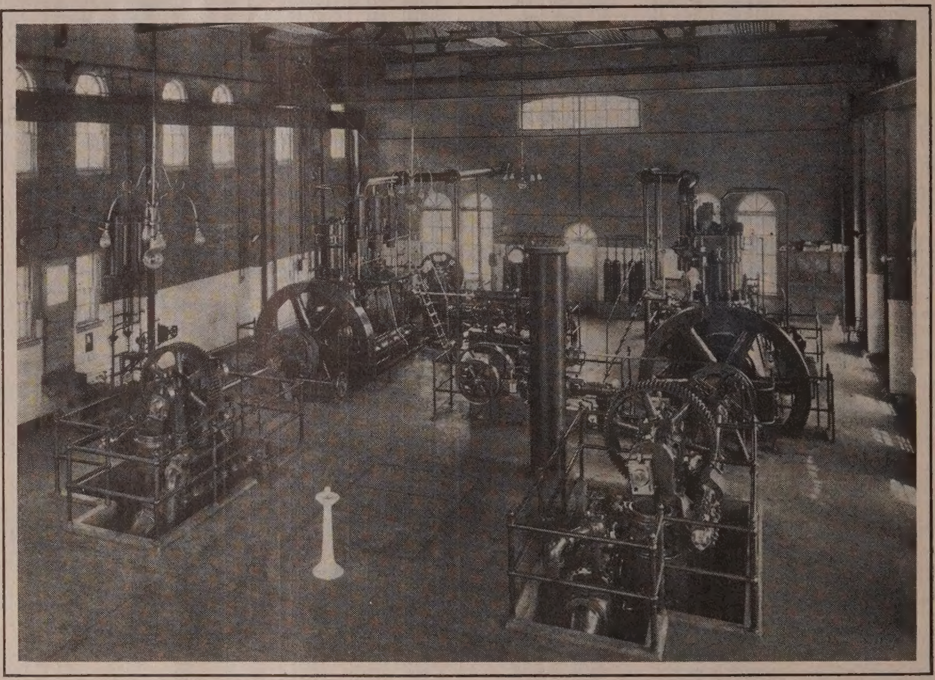
While the table is of large value for a single year and gives fair averages from which deductions may be drawn, the tabulation does not and cannot tell the full story. To be fully comprehensive it should include two, three or, better still, five years. With two years, complete tire changes would show (in a year's schedule a tire change in December would not be listed in the following year's costs), and with three or five years' records the full maintenance and replacement costs would be brought out. Such a plan the department has in mind as based on the system explained in this article.

Pumping Costs with Diesel Engines Given in Detail

Installation in Duplicate at Appleton, Wis., Serves 18,000 Population and Operates Against 185-Foot Head

By H. W. GOCHNAUER
Sanitary Engineer, Department of Water, Appleton, Wis.

DIESEL oil engines, operated for the year ended April 1, 1916, furnished power for the municipal water supply of Appleton, Wis., a city of 18,000 inhabitants, at an average fuel cost of $2.82 per million gallons of water pumped against a head of 185 ft. The installation consists of two 225-brake horsepower, three-cylinder, four-stroke cycle Busch-Sulzer Bros.-Diesel oil engines, located opposite and parallel to each other in such a manner that their air compressors can be belted to either unit. Each engine is directly connected to two Deane double-acting triplex pumps of 2,000,000 gal. capacity each, located one on each end of the engine shaft. The total capacity of one unit, 4,000,000 gal., is sufficient for the city's fire protection. By running the two units alternately, one each week, one unit is always in reserve.



DUPLICATE DIESEL ENGINES PUMP WATER SUPPLY OF APPLETON, WIS., AT COST OF $11.64 PER MILLION GALLONS AGAINST HEAD OF 185 FEET

LIGHTING BILL SAVED

Soon after the plant was put into operation it was found that the cost of current from the local lighting company for lighting the filtration and power plants was about $60 a month, or about half of the entire cost of the fuel consumed in supplying the city with water. To save this expense it was decided to discontinue the purchase of current and install two Allis-Chalmers 15-k.w. 110-volt direct-current generators connected by Link-Belt silent chains, one to each engine. This eliminated the cost of lighting completely, as the generator load on the engines did not sensibly increase the fuel oil consumption over previous months.

Until early in 1915 the station supplied water to the city without stand-pipe or distributing reservoirs, the water being pumped directly into the mains. Due to the fluctuation in the consumption it was necessary to run two pumps continuously, controlling the pressure by means of a Ross regulating valve that by-passed the surplus water to the suction line. This procedure caused a considerable waste of power and was the main cause for the erection of an elevated tank or distributing reservoir of 500,000 gal. capacity, located in the heart of the city.

For the past year, by utilizing the elevated tank, the station has been operating on an average of but 16.2 hr. per day. After the tank is filled one pump holds it full and supplies the consumption demands over night. The shut-down occurs in the morning during the low consumption period of the day, when the demand is met solely by the contents of a full tank.

It was calculated that it would be most economical to shut down at night, when the consumption is at a minimum. However, on trying this out it was surprising to find that during this short shut-down period the cost of lighting the two buildings amounted to approximately $30 a month, which was more than the cost of the fuel oil required to run the one pump and the generator in service during this period. That is to say, it was found that the station could pump water for a period of time equal to the shut-down period, generating its own lighting current, for less than the cost of outside lighting service.

FIRE PRESSURE REGULATED

Fire pressure is supplied by pumping directly into the city mains at a pressure of 110 lb. per square inch. This is accomplished by closing off the elevated tank by means of an electro-hydraulic control operated from the power house. The fire pressure is controlled by the Ross regulating valve. Tests have proved this operation can be accomplished 32 sec. after the fire alarm is received. If the alarm is received while the plant is shut down it is easily and quickly put into operation, the high pressure required being supplied in 3 min.

During the winter, in order to supply the engines and air compressors, a volume of air equal to three times the air displacement of the building must enter through the ventilator in the roof every 24 hours. Consequently, the heating coils were placed on the lower chord of the roof trusses, successfully heating the air as it is drawn into the building. The heating plant, comprising a Spencer boiler, is located in the basement of the adoining filtration plant.

COST OF OPERATION

The operating labor consists of a chief engineer and three assistants, who work in two two-man shifts. Because of the delicacy with which the fire pressure must be controlled, due to the condition of the mains, it is not at all desirable to depend upon a one-man shift.

The accompanying tables, compiled by Chief Engineer Otradov, are self-explanatory and cover the operating data for the year quite completely.

TABLE 1—PUMPAGE AND FUEL OIL CONSUMPTION

Month 1915-16	Total hr. run	Total amount fuel oil	Total pumpage, mil. gal.
April	577	4,562	60.380
May	553	4,310	59.180
June	522	3,814	50.080
July	551	3,972	52.800
Aug.	558	4,156	52.910
Sept.	524	3,660	44.630
Oct.	454	3,458	43.950
Nov.	494	3,466	39.710
Dec.	441	3,310	39.990
Jan.	429	3,378	43.020
Feb.	425	3,226	40.040
March	420	3,298	42.740
Total	5,948	44.610	569.430

TABLE 2—LUBRICATING OIL USED

Month, 1915-16	Lubricating oils used per month (gal.)			
	Cylinder oil	Air comp. oil	Engine oil	Kerosene oil
April	33.00	2.00	8.50	3.00
May	30.75	3.25	8.25	6.30
June	39.25	4.62	11.00	4.87
July	45.00	3.50	10.37	5.37
Aug.	76.00	4.00	18.62	11.25
Sept.	39.25	2.75	12.12	6.50
Oct.	69.00	3.00	7.87	6.50
Nov.	50.25	2.25	6.87	6.75
Dec.	39.75	2.25	8.25	7.25
Jan.	45.25	1.12	6.37	7.62
Feb.	42.00	2.12	6.87	7.62
March	50.00	2.37	4.37	7.50
Total	559.50	33.23	109.46	80.53

TABLE 3—AVERAGE PUMPAGE AND FUEL OIL CONSUMPTION

Month, 1915-16	Av. hr. run per day	Av. amt. fuel oil per day	Av. pumpage, mil. gal. per day	Av. fuel oil per mil. gal. water pumped
April	19.0	152.0	2.012	75.5
May	17.9	139.0	1.909	72.8
June	17.4	127.1	1.666	76.1
July	17.7	128.0	1.703	75.2
Aug.	18.0	133.8	1.706	78.5
Sept.	17.4	112.0	1.487	80.6
Oct.	14.6	111.5	1.416	78.6
Nov.	16.4	115.5	1.280	87.2
Dec.	14.1	106.7	1.287	82.7
Jan.	13.8	108.9	1.387	78.5
Feb.	14.6	111.2	1.380	80.5
March	13.5	106.3	1.377	77.1
Average	16.2	121.0	1.550	78.6

TABLE 4—COST OF OPERATION, APPLETON PUMPING STATION, APRIL 1, 1915, TO APRIL 1, 1916

		Total cost	Cost per million gallons
Fuel oil:			
44,610 gal. at 3.6c. per gal.		$1,605.96	$2.82
Lubricating oil:			
Cylinder, 559.50 gal. at 30c.	$167.85		
Air compress. 33.23 gal. at 30c.	9.97		
Engine, 109.46 gal. at 20c.	21.89		
Kerosene, 80.53 gal. at 8c.	6.44		
		206.15	.36
Labor:			
Chief Engineer	$1,350.00		
Three assistant engineers	2,340.00		
		3,690.00	6.48
Materials:			
Miscellaneous supplies and expenses (heating, telephone, stationery, printing, packing, etc)	887.95		
Maintenance of engines (repair exhaust pipe)	22.64		
Maintenance of pumps	215.95		
		1,126.54	1.98
Total operating cost		$6,628.65	$11.64

NOTE.—A break in the strainer system of the filter plant caused sand to be admitted into the cylinders of the pumps. One cylinder was so badly cut that it was necessary to reline it. The cost of this repair and the expressage on same constitute the pump maintenance.

Meter Maintenance and Repair Systematized in East Orange, N. J., Water Department

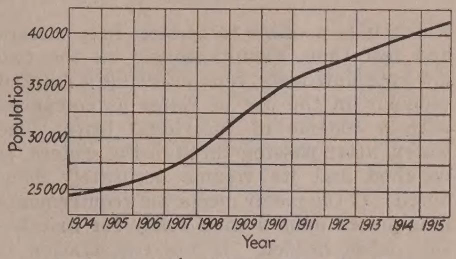
All New Meters Tested at Three Rates—Individual "History Cards" Kept—Per Capita Consumption Reduced to 67 Gal. Daily Last Year

TO supply a population of 42,000 in East Orange, N. J., in 1915 required 175,000,000 gal. less water than was needed in 1910 for only 35,000 people. For this surprising economy meters are accountable. Five years ago the sale of water was based almost exclusively upon a system of flat rates. In 1911 a program of meter installation was begun, and to-day the flow through about 75 per cent of the city's 8100 services is registered and paid for according to a schedule of the amount of water actually used. Reduced to definite terms, the saving effected by the 6000 meters now in service is that resulting from the lowering of the average daily per capita pumpage from 92 gal. in 1910 to 67 gal. in 1915. It is planned to have a 100 per cent metered city by December, 1917, when still further economies are anticipated.

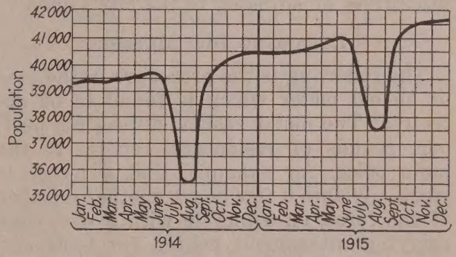
INVESTMENT OF $54,500 IN METERS

The administration of the East Orange water department, however, has not been content with the mere installation of water meters. It is held that the maintenance element is just as important in the water meter problem as in that of good roads, and under the direction of A. A. Reimer, the department's chief engineer, a meter maintenance and repair division has been organized on a systematic basis to safeguard a present investment of $54,500 in water registering devices. This meter division occupies a portion of the department's storage yard building and is charged with the responsibility of keeping the present total of 6000 meters in working order, testing all new meters and maintaining individual records on cards of every meter set or removed. Simplicity is the keynote of the organization and methods. The prime object of the department is to install and repair meters quickly at a minimum cost, and with this idea in mind bicycles, instead of motor cars, are considered entirely satisfactory for the use of the inspection and repair gang, and the card index system is such that a clerk with no qualifications as a cost account expert can operate it.

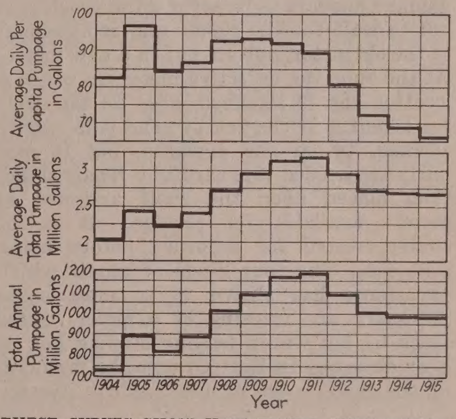
The department's policy has been to purchase and set all meters and bear the expense of normal wear and tear. In case of palpable neglect or the freezing of a meter the property owner is held to account. Every new service connection, for domestic or other purposes, is equipped with a meter, and all charges for water through such services are based upon the established meter rates. The Board of Water Commissioners has authority to install a meter on any service pipe not so equipped, and to determine the size of meter required. Meters are the property of the water department, and are at all times under its control.



EAST ORANGE'S POPULATION GROWTH



MANY PEOPLE LEAVE TOWN IN SUMMER



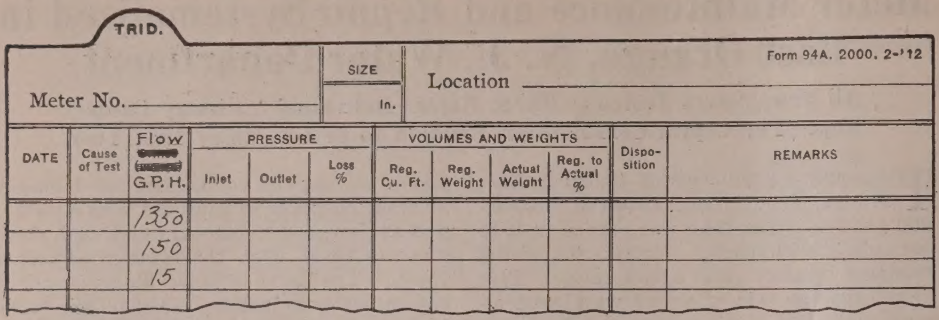
THESE CURVES SHOW HOW WATER CONSUMPTION WAS REDUCED FOLLOWING INSTALLATION OF METERS IN 1911

REQUIRED ACCURACY

East Orange is a residential city, and very little water is used for other than domestic purposes. The prevailing size of meter is ⅝ in., and the disk type predominates. Each new meter, when received from the manufacturers, is tested at three rates of flow before it is placed in service, and must meet the following requirements for accuracy:

Test No.	Rate, gal., per hour	Required accuracy, per cent
1	1350	99-100
2	150	98-102
3	15	90-100

The testing apparatus consists of connections with the city supply, a water tank mounted on scales and a long bench upon



TRID.

Form 94A. 2000. 2-'12

Meter No. ____ SIZE ____ In. Location ____

DATE	Cause of Test	Flow [redacted] G.P.H.	PRESSURE			VOLUMES AND WEIGHTS				Dispo-sition	REMARKS
			Inlet	Outlet	Loss %	Reg. Cu. Ft.	Reg. Weight	Actual Weight	Reg. to Actual %		
		1350									
		150									
		15									

ACCURACY TEST RESULTS ARE REPORTED ON "HISTORY CARD"

which it is possible to connect fifty meters and test them simultaneously on the two low rate flow tests, thus effecting a marked economy in the use of water as compared with a scheme of individual tests. The water, after passing through the meters, is weighed and its volume accurately computed. If the meter meets the requirements it is placed upon a shelf ready for installation when needed. If the registration is inaccurate the meter is returned to the manufacturers or adjusted in the city's shop.

REPAIRING OLD METERS

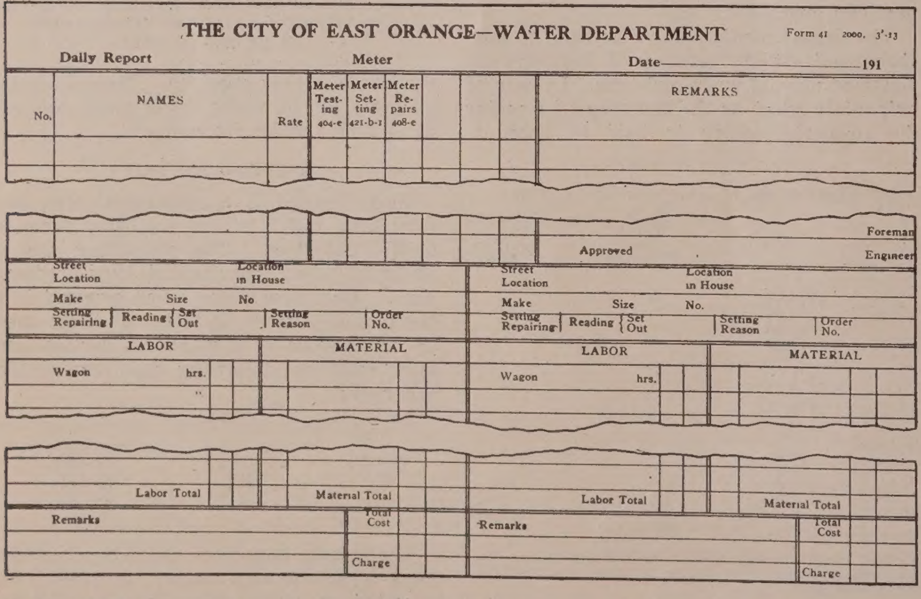
The following is the procedure in the case of an old meter which is found to be defective: The meter reader, during his periodic rounds of residences, reports to the main office, for example, that a meter is stuck. Within a few hours another member of the force, on a bicycle with a wire-cage carrying attachment behind for tools and supplies, proceeds to the premises. If the damage appears to be serious the practice is not to wait for the repair and replacement of the old meter, but to put in a new meter. At the shop the defective meter, to which a location tag is attached, goes on the shelf for repair. If clogged by sand it is merely cleaned, tested and replaced, but if new parts are needed it is carefully repaired and then placed upon the shelf assigned to meters available for service. It is, of course, tested for accuracy before being sent out. The four kinds of repair which experience has shown to be most often necessary are freezing of a meter, meter stuck by hot water, leaking stuffing box or gear defects. In East Orange the majority of the meters are of the Trident, Hersey and Empire make and a sufficient supply of spare parts is always kept on hand so that repairs can be made quickly.

CHARGES FOR REPAIRS

As to charges for repairs, the department bears these except where damage is due to gross carelessness or neglect of the property owner. In the case of a frozen meter or a meter stuck by hot water the consumer pays the repair bill. Stuffing box leaks are, of course, field repairs, and are chargeable to the department, as are also repairs necessitated by worn gearing.

The meter maintenance and testing force is under the general direction of a foreman and includes about 6 or 8 men, depending upon the activities of the department in setting new meters. The testing of a new meter is classified as a general expense, but after a meter has once been placed in service all expenditures are charged to maintenance. There are two meter readers employed at present who spend about two-thirds of their time upon the duties indicated by their titles and the remainder in inspecting plumbing in unmetered houses. It is the custom to set the meters inside the houses, but if a curb setting is required the cost is charged to the property owner. In ordinary settings, if the work is simple, no charge is made, but if the department's men are required to tear up flooring, or if the pipes are buried under coal bins and otherwise difficult to reach, a bill for this extra labor is forwarded to the house owner. Including the time of the men, wagon and material, the cost of setting a new meter averages $1.25.

While bicycle transportation is generally resorted to for meter maintenance and repair work, a horse and wagon have been found useful in the operations of setting new meters. The city occupies an area of only 4 sq. miles, so that the matter of transportation from one point to another is never very serious.



THE CITY OF EAST ORANGE—WATER DEPARTMENT Form 41 2000. 3'-13

Daily Report Meter Date________191

No.	NAMES	Rate	Meter Testing 404-e	Meter Setting 421-b-1	Meter Repairs 408-e				REMARKS

Foreman

Approved Engineer

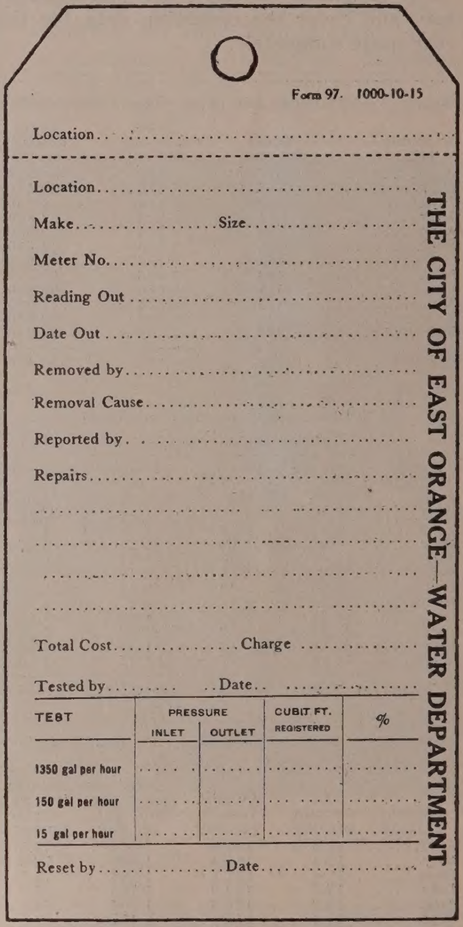
Street Location	Location in House		Street Location	Location in House	
Make Size No			Make Size No.		
Setting Repairing	Reading { Set Out	Setting Reason Order No.	Setting Repairing	Reading { Set Out	Setting Reason Order No.

LABOR		MATERIAL	LABOR		MATERIAL
Wagon	hrs.		Wagon	hrs.	
	"				
Labor Total		Material Total	Labor Total		Material Total
Remarks		Total Cost	Remarks		Total Cost
		Charge			Charge

ON THIS FORM THE FOREMAN OF THE METER DIVISION REPORTS THE KIND OF WORK DONE BY HIS FORCE AND THE LOCATION OF METERS REMOVED OR SET

METER "HISTORY CARDS"

It was not until the year 1911 that a big campaign of metering was begun. Sufficient time has not elapsed, therefore, to secure conclusive figures on the life of a meter and its maintenance cost. This matter, however, is not being neglected, and Mr. Reimer has devised a system of "history cards" by which a complete record of the meter is kept. On these cards, of which a sample is shown, are reported the results of the first accuracy test and any subsequent tests, together with the reasons for taking a meter out after it has once been placed in service. The daily report of the meter foreman also is standardized, and the accompanying blank form gives an idea of the kind of information he supplies. Each history card has a tab upon which the brand of the meter is printed, and for each brand a distinctive color is employed.



Form 97. 1000-10-15

Location.........

Location.........

Make.........Size.........

Meter No.........

Reading Out.........

Date Out.........

Removed by.........

Removal Cause.........

Reported by.........

Repairs.........

Total Cost.........Charge.........

Tested by.........Date.........

TEST	PRESSURE		CUBIT FT. REGISTERED	%
	INLET	OUTLET		
1350 gal per hour				
150 gal per hour				
15 gal per hour				

Reset by.........Date.........

THE CITY OF EAST ORANGE—WATER DEPARTMENT

THIS IDENTIFICATION TAG IS ATTACHED TO OLD METERS JUST BEFORE THEY ARE TAKEN OUT FOR REPAIRS

As has been pointed out in a preceding paragraph, no attempt at an elaborate system of records or costs was attempted. The advantages of the system now in force are that it is workable and requires very little time for its upkeep.

Nicholas S. Hill, Jr., present president of the American Waterworks Association, is president of the Board of Water Commissioners of East Orange, the other members being T. F. Macksey and H. D. Reed.

New Water Supply for Small Town Involves Earth Dam, Filters and Pipe Line

Hard and Impure Well Water at Le Roy, N. Y., Abandoned in Favor of Gravity System Recently Placed in Service

By JAMES P. WELLS
Consulting Engineer, Rochester, N. Y.

AFTER suffering for 20 years from an inadequate supply of impure, hard well water, the village of Le Roy, N. Y., two months ago placed in service its new gravity system, comprising an earth dam 500 ft. long and 32 ft. high, a 1,000,000-gal. per-day mechanical filtration plant and a 14-in. cast-iron pipe line 5 miles long, laid in record time. Before the new system was placed in operation the consumption of water in Le Roy averaged only 200,000 gal. per day. As the old supply, on account of its hardness, was used very little for washing and factory purposes, it was estimated that with the new supply of soft water the consumption would reach 400,000 gal. per day, or about 100 gal. per capita. From data as to past growth it is estimated that in 35 years the population would increase to 7000 and that a supply of 700,000 gal. per day would be sufficient. Estimates were made and an appropriation of $105,000 was made for the construction of the new system, with $15,000 for extensions and improvements to the distribution system. Work was started in September, 1915, and in the fore part of April, 1916, the water was turned into the mains.

AT THE SITE OF THE DAM CLAY SOIL IS UNDERLAID BY SHALE ROCK

The reservoir has a capacity of about 175,000,000 gal. Eighty-three per cent of this amount, 145,000,000 gal., is in the upper 14 ft. and is available for use. The reservoir was formed by the construction of two earthen dikes and an earthen dam with a concrete core, and has an area of 55 acres when full.

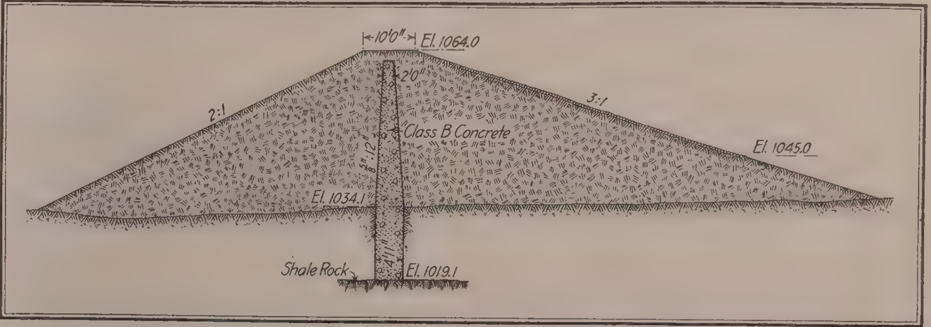
MINIMUM RUN-OFF ESTIMATED

Mad Creek, the stream upon which the dam has been constructed, has a drainage area slightly in excess of 1½ sq. m. From records of adjacent streams it was estimated that in an extreme low year the average daily run-off for the entire year would be at least 900,000 gal. per day. The run-off during the early part of the year is sufficient to keep the reservoir filled until the latter part of May or June. As there is occasionally a year when the run-off is very slight during the last six months it was considered advisable, even though there is always some run-off, to construct a reservoir of sufficient capacity to furnish 700,000 gal. per day for six months without its being replenished by any inflow. This amount of water is equivalent to 126,000,000 gal. The reservoir was accordingly designed to have a capacity of 145,000,000 gal., a liberal amount being allowed for evaporation and seepage. At the time of writing the reservoir is full and overflowing and enough water has wasted over the spillway to refill it.

EARTH DAM AND DIKES

Test pits at the site of the dam indicated that an earth structure with a concrete core would be much cheaper than either a concrete masonry or a reinforced concrete dam of the Ambursen type. The bed of the reservoir is composed of a heavy, clayey soil. This is underlaid by shale rock. At the central portion of the dam this rock is 16 ft. below the surface. At both ends of the structure no sheeting was necessary for the core wall trench as the material was stiff clay and hardpan. At the center of the dam considerable water was encountered. The material was sandy clay and great difficulty was experienced in deepening the trench, it being necessary to work day and night. The core was carried to the rock for the entire central portion of the dam.

The greater part of the material for the earth fill was excavated by an elevating grader loading directly into dump wagons from a borrow pit just east of the reservoir. The remainder was placed by wheel scrapers. On the upstream portion of the structure fine, clayey material was deposited in 6-in. layers. This was then watered and rolled with a 2-ton, grooved roller. The coarser and more porous material was used on the downstream side. The width of the dam is 10 ft. at the top with an upstream slope of 3 to 1 and a downstream slope of 2 to 1. Severe winter weather set in before the work was completed so that it was necessary to leave the work when the embankment had been carried to the top of the core, 3 ft. above the crest of the spillway. Although the wetting and rolling of the embankment was materially aided by considerable rainfall during the construction there was some settlement when the water reached its full height. The accompanying photograph shows the cracks formed along the core due to this settlement. Riprap, 1 ft. thick, was placed on the upstream face of the dam to a depth of 14 ft. below the spillway crest, the point of lowest draft. The earth dikes in no case exceeded a height of 9 ft., and as their crest is 5 ft. above the normal water level they were made 5 ft. wide at the top with 2 to 1 slopes on each side.



THE EARTH DAM IS 500 FT. LONG, 32 FT. IN MAXIMUM HEIGHT AND HAS A CONCRETE CORE WALL

SPILLWAY

The concrete spillway was designed with a width of 60 ft. at the point of overflow. Its crest is 5 ft. below the surface of the dam. For the size of the stream a spillway width of 60 ft. is perhaps somewhat greater than is ordinarily allowed, especially with a reservoir area of 55 acres, which will temporarily store a large amount of water and greatly decrease the intensity of a flood. However, in the light of the recent flood at Erie, where the flood rate was about 900 sec.-ft. per square mile from a stream with a drainage area ten times the size of Mad Creek, it is evident that such a spillway width is not too great.

CONCRETE

The concrete in the core was of the proportion 1:3:6; that in the spillway, 1:2½:5. The gravel was obtained from a pit ¾ mile east of the works. The location of the spillway, core wall and filter plant was such that considerable economy could be effected in the placing of the concrete. An 18-cu.-ft. Koehring mixer was placed at each end of the core wall. Practically all the concrete, not only in the core wall but in the spillway and filter plant, was poured from these mixers through open chutes without changing their position.

FILTRATION PLANT

Water passes from the reservoir into the filter plant through a 16-in. cast-iron pipe. Before entering the sedimentation basin it is aerated by a fountain in a small building attached to the filter house. After aeration the water descends through a Venturi tube into the sedimentation basin. The Venturi tube was installed to automatically regulate the flow of chemicals. Up to the present time it has been found necessary to use only sulphate of alumina. There are two beds in the plant, each with a normal capacity of 500,000 gal.

Leading from the clear well of the filter plant is a 14-in. cast-iron pipe which carries the water to Le Roy. Remarkable progress was made in its construction. With the exception of 100 ft. of hard limestone rock in the lower portion of the trench the entire 24,500 ft. was excavated with an Austin trenching machine. Of this amount 500 ft. extended through shale rock, 3 ft. of which occurred in the bottom of the trench. There were also 700 ft. of woods. The first 22,000 ft. of the line, which included the sections of rock and woods, was completed, including the backfill, in 35 days, an average of 750 ft. per day. The greatest amount of trench excavated during any one day was slightly over 1000 ft. and the record for laying pipe was eighty-five 12-ft. lengths. This record is not often excelled and it was made possible by the efficient manner in which the contractor handled the work.

In order to increase the supply of water available at Le Roy for fire protection purposes an elevated tank with a capacity, when full, of 130,000 gal. has been constructed, in addition to the old stand pipe.

THIS METHOD OF BACK-FILLING THE PIPE LINE TRENCH DID NOT PROVE VERY SATISFACTORY

There is sufficient pressure from the new system to raise the water above the top of the old stand pipe, but in case of a large fire there would be considerable head lost in friction from the reservoir to Le Roy. For this reason it was considered advisable to have more water available directly at the distribution system. In addition to this several dead ends will be connected, which will greatly improve the fire protection in the factory district.

It is often the case that many a meritorious engineering project has not been approved by the public simply because the public did not understand it. In this instance all the details of the proposition were presented in a way which the people could easily understand by E. M. Perkins, editor of the local paper. As the plan involved the construction of a storage reservoir on a stream which sometimes goes dry in summer there was naturally much apprehension. While engineers are satisfied that water filtration is an effective means of purifying water, it is not always an easy matter to convince the general public. Now that the plant is in operation the citizens are more than satisfied with the results, for in addition to having water in abundance, analysis of the new supply shows the presence of no B. coli and gives a bacterial count equal to about 3 per cent of that of the old supply. The water is also sufficiently soft so that it may be used for all purposes.

CONCRETE FOR THE CORE WALL WAS POURED TO PLACE THROUGH OPEN CHUTES

PERSONNEL

The dam and the concrete work on the filter plant were built by Morrison & Quinn, of Rochester, N. Y. The Norwood Engineering Company, of Florence, Mass., designed and built the filter plant. The cast-iron pipe was furnished by the United States Cast Iron Pipe & Foundry Company and the line was laid by Charles Shepard, of Niagara Falls. The writer prepared the plans and supervised the construction of the work and also engaged Walter McCulloh, of Niagara Falls, N. Y., to act as consulting engineer. O. S. Hart was assistant engineer.

Exports to South America Doubled

Exports from the United States to South American countries were more than doubled during the past year, according to data collected by the Bureau of Foreign and Domestic Commerce.

SETTLEMENT CAUSED CRACKS IN THE EMBANKMENT ABOVE THE CORE WALL

Twin-Tube Venturi Meter Aids Water Waste Detection

Apparatus Developed at St. Johns Is Sensitive for Wide Range of Flow and Is Simple to Operate

By FRANCIS F. LONGLEY

Of the Firm of Hazen, Whipple & Fuller, Consulting Engineers, New York

WITH a new type of Venturi meter apparatus, designed especially to record wide ranges of flow with extreme sensitiveness, it has been possible, in an investigation of water waste at St. Johns, Newfoundland, to detect leakages as small as ½ gal. per minute. This result has been accomplished by the use of two meter tubes of different diameters, assembled in a single, portable unit which has proved its usefulness on the waste detection work which the writer's firm has been conducting. At first various temporary expedients, devised from materials ready at hand, were used in order to get a general and approximate idea of the waste from different sections, and finally the desire to secure more accurate information resulted in the design of the equipment described below.

TWIN-TUBE APPARATUS DEVELOPED

The methods that were being used in St. Johns involved the isolation of districts of the distribution system and the supplying of the isolated district through a line of fire hose connecting a hydrant within with a hydrant outside of the district. The problem then resolved itself into the design of an apparatus by means of which small changes in rate of flow through this hose could be readily and accurately observed. A Venturi meter tube with its indicator, at once simple, sensitive and accurate, seemed to offer many advantages for this purpose, but a single meter tube has not range enough in capacity to cover all the possible rates of flow that might be encountered in such a study as this. A logical development of the Venturi meter idea, then, required the use of two or more meter tubes so arranged that the flow could be diverted through that one whose capacity most nearly met the immediate requirements.

The writer thereupon submitted to the Builders Iron Foundry a sketch showing the general requirements for this apparatus, and that firm perfected a design in which two meter tubes were erected, one above the other, on a light but rigid framework of wrought-iron pipe. A single manometer tube of the barometric type was provided with two scales, one for each of the meter tubes, and the manometer was suitably connected to the mouth and throat of the two meters through three-way cocks in such a manner as to insure connection with the right tube.

The apparatus, as assembled in one unit, is shown on the accompanying photograph. The two Venturi meter tubes used for the St. Johns equipment were a 3-in. tube with 1½-in. throat and a 2-in. tube with ⅝-in. throat. The 2-in. tube is in a by-pass line around the 3-in. and water can be passed through either meter tube from the common inlet by properly manipulating the gate valves *M* and *N*, which have a common outlet as shown. The three-way cocks, marked *K* and *L*, transmit respectively the inlet and throat pressures from the 3-in. and 2-in. meter tubes to the manometer and they are so arranged that the pressure from

TWIN-TUBE VENTURI EQUIPMENT IS SENSITIVE FOR WIDE RANGE OF FLOW

A, manometer; *B*, 2-in. meter tube; *C*, inlet; *D*, 3-in. meter tube; *E*, outlet; *K* and *L*, three-way cocks; *M* and *N*, gate valves.

treme low portions of the scale. Making allowance for this overlapping of capacity, the equipment provides a measuring range of approximately 3 to 200 U. S. gal. per minute. The size of the isolated district can in general be adjusted to conform to some convenient portion of this range.

The statement that the minimum point of the capacity range is 3 gal. per minute does not mean that that is the limit of sensitiveness for observing changes in rate. While 3 gal. a minute is about the smallest total quantity that can be measured with dependable accuracy with these meter tubes, variations in rate of flow very much smaller than that can be readily observed. On the 3-in. meter tube, for instance, a change in the height of the mercury column of ¼ in. at or near the top of the scale corresponds to a change in rate of flow of about 1½ gal. per minute. For the 2-in. meter tube a change of ¼ in. in the height of the mercury column when it stands at or near the top of the scale corresponds to a change in rate of flow through the meter of only about ¼ gal. per minute, and even at the lower

an air-lift well-pumping installation developed an over-all efficiency of 59 per cent, measured between the steam end of the compressor and the point of delivery of the water. From the Standard Supply & Equipment Company, of Philadelphia, which furnished the air-lift outfit, the following information regarding the test has been received. The figures have been submitted to and checked by James H. Long, chief engineer of the Camden Water Department.

RESULTS OF TEST OF 8-INCH WELL AT CAMDEN

1. Total depth, 120 ft.
2. Diameter, 8 in.
3. Depth to foot piece, 106 ft.
4. Foot-piece to umbrella, 115.5 ft.
5. Water eduction pipe, 5 in.
6. Air pipe, 1¼ in.

Cu. ft. free air per min.	Gal. per min.	Shut in pres.	Well press	Cu. ft. air per gal.	Submergence, per cent	Lift, ft.	Water horsepower	Air horsepower	Efficiency
50	300	31.5	35.3	0.166	63	42.8	3.22	5.40	59.6
60	322	31.0	35.5	0.186	62	43.9	3.56	6.54	54.2
100	392	27.5	37.5	0.255	55	52.0	4.55	11.30	40.2

WELL 120 FEET DEEP

The well was 120 ft. deep and 8 in. in diameter. The water eduction pipe was 5 in. and the air pipe 1¼ in. in diameter. The depth to the foot-piece was 106 ft. and from the foot-piece umbrella 115.5 ft. The air-lift was of the Talbot type. In installing this apparatus the practice is to consider each well as an individual problem and adapt the pumping rigs to the local conditions encountered. When once the pumping conditions are known the whole apparatus, from foot-piece to point of discharge of the water, is designed to fit those conditions exactly, as regards both size and general construction.

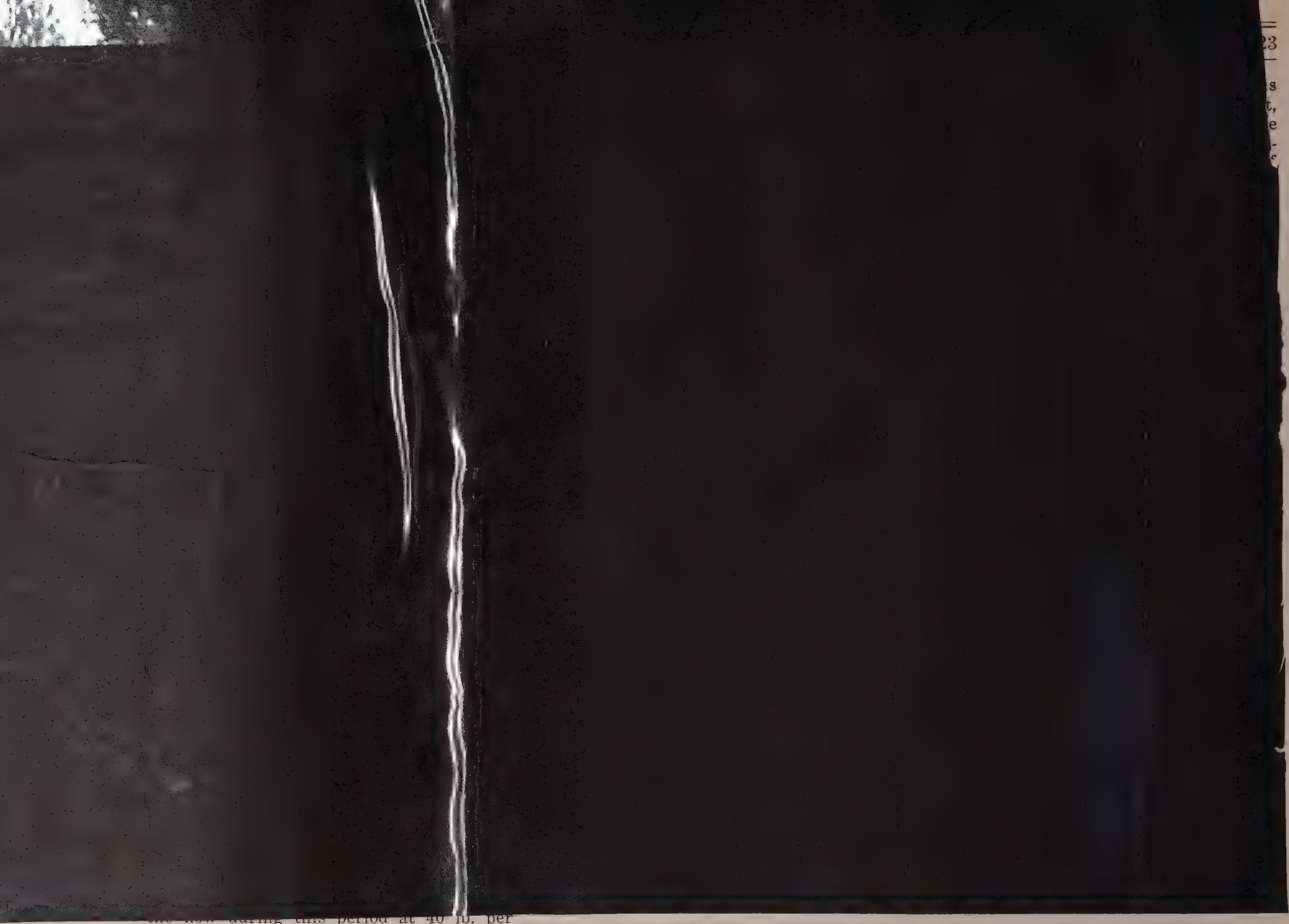
The most important conclusion to be

Gallons per Minute

CURVES OF EFFICIENCY AND AIR CONSUMPTION

large iron tank for an interval of time taken by stop watches. An umbrella deflector was used at the top of the water eduction pipe, and the water was caught in a small wood tank surrounding the latter. This tank was fitted with a 6-in. outflow pipe about 4 ft. long, having an ell and short nipple on the outer end. By turning the ell, which was left loose on the horizontal pipe, the water could be directed into the measuring tank or out on the ground at will.

The curve of efficiency shows a steady falling off as the pressure is increased and more water pumped. This is to be expected for two reasons: First, because of the lower submergence when pumping the larger quantity; second, because of the greatly increased friction of water and consequent slippage of air at the higher velocities of discharge. This friction and slip, it is held, is the greatest contributing cause of the inefficiency of most air-lift systems. Careful design of the apparatus in the present case so as to reduce this factor to a minimum is claimed to be the chief reason for the results obtained.



THESE EDUCATIONAL ADMONITIONS APPEAR ON BACKS OF QUARTERLY BILLS

the flow during this period at 40 lb. per square inch.

Systematic inspection was started in 1915 of all meters which had not been inspected for accuracy within the past five years, and all meters on the system purchased from the Public Service Company in 1912. The work will be concluded in 1916. The thorough inspection of all services and hydrants to locate underground leakages reduced the waste so materially that the use of water due to 660 added services (making 7000 in all) was not noticeable.

In 1915 there was an actual increase in the daily consumption of 40,600 gal. per day, and if there had been no reduction in waste the average daily consumption (based upon the per capita consumption of 1914) would have been at least 2,232,600 gal.—that is to say, 200,000 gal. above what it actually was. Of this latter quantity 70,000 gal. a day was underground leakage, while the remaining 130,000 gal. was saved by the reduction in fixture leakage and had previously been paid for by consumers.

All complaints concerning high water bills are investigated and a comprehensive written report is made to the consumer. Absolutely no reductions in bills are made for excessive water used due clearly to leakage. Some leniency in terms as to date of payment is occasionally entered into, but in general the rules are rigidly observed. A campaign was conducted to educate the consumer in the prevention of needless waste and in methods of detecting leaky fixtures.

Whenever a complaint is made concerning a high bill the consumer is given the benefit of the doubt from the first. The nature termine whether or not he has found the cause of the high bill. If the leaks found are not sufficient in size or number, or no leaks or signs of waste are found, the occupants are questioned as to the number of people in the household during the period covered by the high bill, number of automatic devices depending upon water pressure, such as thermostats, hydraulic pumps, etc., and whether or not a plumber has done some work in the house. This latter information is generally withheld by the complainant himself. The inspector then turns in the reading of the meter to the office with all the facts he has been able to obtain.

In case leakage is found the complaint clerk writes a formal letter to the complainant giving the result of the investigation, together with information regarding the effect of leaks upon water bills.

If no leaks have been found, and the cause of the excess consumption cannot be determined, a second reading of the meter is taken a week after the first inspection. This gives the "present rate of consumption," and shows whether or not the conditions have changed. If the consumption has dropped to "normal," it is assumed that the causes of the excess consumption were removed by the complainant just before he applied for the investigation, or perhaps just before the inspector made the first trip. The water department therefore reports that the conditions which caused the high bill have been removed, and gives the present quarterly rate.

Although the consumer invariably accepts the results of these investigations and 1 per cent are not satisfactory to the complainant. Payment of excessive bills, however, is not enforced until a complete investigation has been made and the charge is proved to be a just one. It has been found that leniency encourages waste.

Some plumbers who fail to appreciate small leaks often mislead the water takers, but the latter are becoming educated and the plumber has to make good.

In the distribution of the consumption 80 per cent was accounted for by consumers' meters, 4 per cent was used for construction, street sprinkling, flooding of skating rinks and fires, 3 per cent for sewer flushing, hydrant flushing, emptying of pipes for repairs, etc., and 13 per cent was unaccounted for, including loss from leakage, stoppage of meters, etc.

The apportionment to various uses is as follows: Domestic—residences and apartments, 65.2 per cent; commercial use—dairies, laundries and stores, 5 per cent; public use—schools, public buildings, hospitals, fires and streets, 7.9 per cent; industrial use—public service corporations, 8.9 per cent; unaccounted for—underground waste and under-registration of meters, 13 per cent.

WHY METERS ARE REPAIRED

Of the 1153 meters (16.5 per cent of the total number in service) sent to the shops for repair during the year, 15.4 per cent had been damaged by heat and 5 per cent by frost; 17.7 per cent were stopped by dirt or by a broken disk; 21.5 per cent were old water-piston meters replaced by new disk meters; 31 per cent were tests of meters on the system purchased from the Public Service Company, and 9.4 per cent were leaking or damaged externally, stopping the flow of water.

The number of calls of inspectors, 3532, was 50 per cent of the number of accounts. Of these inspection calls 17.9 per cent were to investigate the reason for high bills and only 6.5 per cent were made to shut off the water for non-payment of bills.

Oak Park is one of the largest municipalities to cling to the town system of government. In an election last spring the voters overwhelmingly defeated a proposition to change to a city with a council form of government. At present the affairs are handled on a business basis with W. F. Sargent, commissioner of public works, exercising practically the same powers as a city manager. Reporting to him is H. P. T. Matte, superintendent of the water department.

The following are samples of rubber stamps used when the occasion requires:

Oak Park, Ill...............191..

M........................

....

Oak Park, Ill.

Our meter reader reports that meter at the above address registers......................gallons from ....to............amounting to $........

He finds this higher than the usual consumption and thinks it may be caused by waste in some form, such as defective plumbing, leakage or carelessness. Unless you can account for same it would be advisable for you to investigate in order to avoid future large water bills.

WATER DEPARTMENT.

....

........................,

Your complaint will be given immediate attention and result of investigation will be reported to you by inspector or by mail.

OAK PARK WATER DEPARTMENT.

One-Third of Los Angeles Water Supply Now Furnished by Aqueduct

Approximately one-third of the water supply of Los Angeles is now furnished by the aqueduct, according to information recently given to the Los Angeles Public Service Commission by William Mulholland. It was also stated that the operation of pumps in the southern part of the city had been discontinued, thus effecting a saving of about $65,000 annually.

Old Pipe Relaid for Galveston's Submerged Line

To Guard Against Storm Damage to Causeway Line a Second Main Is Laid on Bottom of Bay

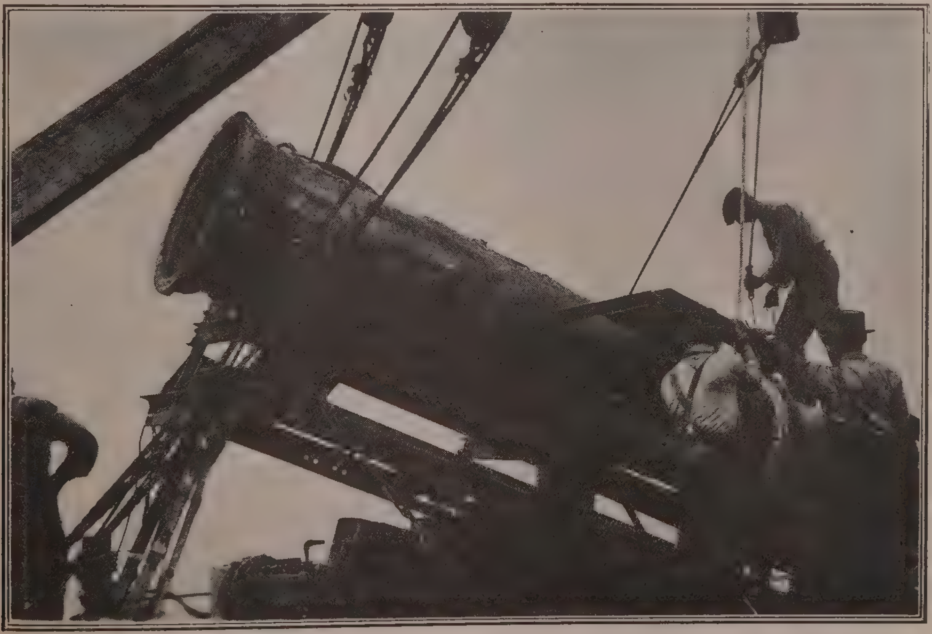
By E. B. VAN DE GREYN
Consulting Engineer, Houston, Tex.

THE water supply for Galveston, Tex., which was interrupted by the breaking of the main supply pipe during the great storm last year, is now brought through the repaired 30-in. pipe line on the causeway. The restoration of the water supply was described in the Engineering Record of Oct. 23, 1915, page 500. In order to provide against a repetition of a water shortage the city is laying a submerged pipe line 30 in. in diameter approximately 10 ft. below the bottom of the bay, connecting at the mainland and at the island with the present 30-in. main. Plans called for the use of all good and serviceable pipe taken from the old line which was laid originally on the bottom of the bay and which was broken at several points during the storm. No flexible joint pipe are used. The city let the contract to Isaac Heffron of Galveston.

DREDGE AND SCOW—GALVESTON CAUSEWAY AT LEFT

SEQUENCE OF OPERATIONS

Work was started at a point about 1500 ft. from the mainland, where the water is of sufficient depth to float the suction dredge which digs the trench for the new pipe line. Next comes a derrick barge which picks up the old submerged line. It is followed by a barge from which is laid the new submerged pipe. In the deep part of the bay the new line is about 18 ft. below water surface. At the shore end, where the water is too shallow to float the dredge, open cofferdams will be used.



CALKED PIPE SECTION AT TOP OF CRADLE READY TO SLIDE WHEN BARGE IS MOVED

The suction dredge excavates a trench approximately 10 ft. below the bottom of the bay. Below the mud hard material is encountered which makes dredging slower. This hard material will furnish a firm bed for the pipe and it is unlikely that it will be scoured out, especially when the causeway approaches are reconstructed with arches giving much additional waterway.

In taking up the old pipe line a diver makes a hitch around the end of the pipe and a hitch just back of the first bell from the end. The pipe is then raised and lowered a little until a joint breaks loose, when the sections broken loose are lifted onto the barge. From one to three or four, but generally two or three, sections are brought up at a time. Only good pipe are used for the new main, cracked or broken pipe are discarded. Lead is removed from joints by melting with oxy-acetylene flame.

Both ends of the barge are equipped with derricks. One of them has pile driver leads suspended at the end of the boom and is used to drive piles on both sides of the barge to hold it in position. The other derrick handles the pipe, cradle, etc. An air compressor on the barge furnishes pressure for calking pipe joints.

PIPE-LAYING CRADLE

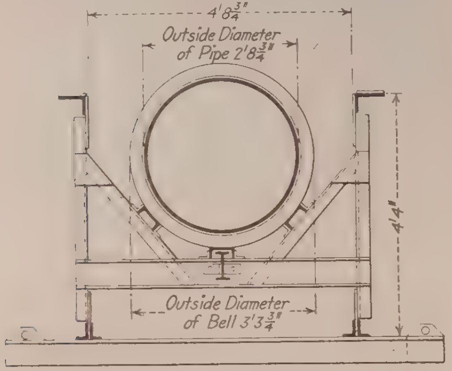
The pipe-laying cradle is made entirely of steel. The general plan for the cradle was supplied by the contractor and his assistants; the detailing and building were done by the Texas Carnegie Steel Company, of Galveston. On the line of its bottom chord the cradle is 108 ft. long, made up of nine panels of 12 ft. each. The cradle is curved by making deflection of 6 in. in each 12-ft. panel. The 30-in. pipe rests and slides on three channels.

One end of the cradle rests on and is secured to the end of the barge. The other end rests on the bottom of the trench excavated by the suction dredge. The curved form of the cradle allows the pipe to reach its position in the trench without shock. As the barge moves forward it drags the cradle with it, the cradle sliding out from under the pipe.

As soon as a joint is poured the barge is moved forward one pipe length, dragging cradle with it. While the next section of pipe is being placed in the cradle the lead joint is trimmed and calked. To move the barge forward each time the boom is lowered, a hitch taken about the upper end of the pipe, and strain put on load line, this being equivalent to pushing against the end of pipe line. Barge and cradle then move forward. The use of an air compressor in calking joints facilitates the pipe laying work. On an average, twelve sections or 144 ft. of pipe is laid per 9-hr. day. On one day about 50 per cent more than this amount was laid. The use of the cradle

LOOKING DOWN ALONG THE STEEL LAUNCHING CRADLE

and the driving of piles on both sides of the barge put the laying of the submerged line under good control. If it becomes necessary on account of storm to remove the barge the piles can be cross timbered and braced and the cradle and pipe lashed to the bent. These piles are pulled and used again as the barge moves forward.


4'8¾"
Outside Diameter of Pipe 2'8¾"
4'4"
Outside Diameter of Bell 3'3¾"

HOW PIPE IS SUPPORTED BY CHANNELS ON CRADLE

The pipe line is to be tested under 40 lb. pressure. Any leaks developed will be calked by a diver.

[The cradle described is similar to the one used in laying the Narrows siphon flexible joint pipe line for the New York Board of Water Supply.—Editor.]

Blueprint Clogs Air Filter System

For safekeeping an over-careful foreman put a 3 x 4-ft. blueprint in the intake box of the air compressor supplying the filters of the Bubbly Creek plant of the Union Stock Yard & Transit Company, Chicago. The night attendant washed two or three filters the same night. Business of hunting everywhere for the blueprint next day by the foreman and final confession as to his safety deposit vault. The 40-mesh seive over the intake valve was found torn sufficiently to let the folded blueprint enter. Fragments were found throughout the whole system, as the valves acted as a shredder. The wet, macerated paper stock clogged the small holes in the air system to such an extent, according to C. A. Jennings, superintendent, that the filter media must be removed and each lateral cleaned.

Chlorine Gas Reduced Water Sterilizing Costs

Operating Records of Two Types of Plant, Compared, Show Hypochlorite Treatment Involves Greater Expense

By C. O. JOHNSTON
Johnstown (Pa.) Water Company

BY substituting chlorine gas for a solution of hydrochlorite of lime as the sterilizing agent for the water supply of Johnstown, Pa., a saving of 300 per cent in operating costs will be realized. This estimate is based upon the recent advance in the cost of hypochlorite from $1.60 to $12.50 per hundredweight. Comparative costs of the two methods of treatment are given in the accompanying tables.

SUPPLY FROM SEVERAL SOURCES

A brief description of the Johnstown Water Company's system is necessary to enable the reader to appreciate fully the cost of treating the water. Johnstown lies in the foothills of the Allegheny Mountains at El. 1165 to 1800, and on account of the topography the largest watershed contains 10 sq. miles, while the smallest contains only 4.85 sq. miles. The population of Johnstown and suburban districts is approximately 90,000, of which 70,000 are supplied by the Johnstown Water Company, which derives its supply from a number of sources.

The water from the St. Clair reservoir was first treated in 1910 by erecting a hypo plant directly over the bulkhead. The solution was fed into the main through a 1-in. pipe perforated at the bottom. The water from Laurel Run, Red Run and Wild Cat was also treated, at first, with hypochlorite by erecting a plant and feeding a sufficient amount of the solution into the Red Run supply main to treat the water of Laurel Run and Wild Cat. The Benscreek hypo plant treats the combined supply of Mill Creek 1 and 2, Dalton Run and at times North Fork.

At the Benscreek plant the hypochlorite is weighed, 50 lb. at a time, and put into the emulsion or mixing tank and allowed to dissolve for approximately 12 hr., after which the remaining lumps are thoroughly broken up and mixed by water the pressure of which is 100 lb. The water flows through holes drilled in a 1-in. pipe forming a grid in the bottom of the tank. We use a ½-per cent solution (50 lb. hypo and 1200 gal. water), as we have found through a series of tests that the treatment is more efficient by using more of the weaker solution than less of a stronger solution. The solution flows from the emulsion tank into any one of three storage tanks and is again thoroughly mixed by revolving paddle agitators for 2 hr., after which the solution is allowed to settle before being fed into the orifice tanks.

This plant has been in constant operation 24 hr. a day and 364 days a year since 1911, with the exception of one day each year to make slight repairs to piping and to grind tank valves. The operating cost has averaged $2.155 per million gallons treated, including labor, general expense and chemicals.

Our main objections to hypochlorite treatment are, first, the actual and imaginary taste of the treated water at different periods of the year; and, second, the high cost of plant and its operation.

On the completion of our Saltlick reservoir it was decided to use chlorine gas, and after a careful study we chose the Wallace & Tiernan direct-feed machine. This machine was installed in the effluent tower, and a ½-in. galvanized pipe was run down the inside and connected to the 20 and 30-in. supply mains at two different elevations in order to reduce the amount of head the machine would have to work against (i.e., top elevation is used when reservoir is full, while the lower elevation is used when the water in the reservoir drops 25 ft.).

After four months of careful study we found that chlorine gas sterilization overcame all our objections to hypochlorite and we decided to change the St. Clair and Laurel Run plants by using the same kind of machine. At the present writing we are abandoning the Benscreek hypochlorite plant by installing three additional Wallace & Tiernan machines. Mill Creek water and Dalton Run water will be treated by installing a direct-feed type A machine in the valve house at the foot of the reservoir, while the water from North Fork will receive its treatment by using a type A machine the diffuser of which will be placed in the mouth of a 24-in. main, under 3-ft. head of water.

COSTS OF TREATMENT WITH CHLORINE GAS

	Mil. gal. treated per month	Lb. of chl. gas per mil. gal.	Avail. chlorine p.p.m.	Cost per mil. gal. treated: Gas	Labor and gen. exp.	Total
St. Clair Plant (Oct., 1915-April, 1916—Total of 96.889 mil. gal. treated)						
*Max.	17.942	4.58	0.56	$0.424	$1.991	.....
Min.	12.658	1.74	0.22	0.161	1.098	.....
Av.	.....	3.09	0.38	0.277	1.527	$1.804
Laurel Run Plant (Oct., 1915-April, 1916—Total of 512.63 mil. gal. treated)						
*Max.	92.96	2.17	0.26	$0.196	$0.282	.....
Min.	76.42	1.79	0.22	0.161	0.208	.....
Av.	....	1.99	0.24	0.179	0.257	$0.436
Saltlick Gas Plant (June, 1915-April, 1916—Total of 981.34 mil. gal. treated)						
Max.	129.67	2.45	0.29	$0.221	$0.589	.....
Min.	72.56	1.25	0.14	0.113	0.257	.....
Av.	....	1.76	0.21	0.158	0.342	$0.501

*Based on monthly averages.

COSTS OF TREATMENT WITH HYPOCHLORITE

	Mil. gal. treated per month	Lb. of hypo. per mil. gal.	Avail. chlorine p.p.m.	Cost per mil. gal. treated: Hypo.	Labor and gen. exp.	Total
St. Clair plant (Nov., 1914-Oct., 1915—Total of 136.7 mil. gal. treated)						
*Max.	15.337	12.69	0.48	$0.208	$14.090	.....
Min.	9.284	7.40	0.31	0.122	8.184	.....
Av.	.....	9.64	0.36	0.158	11.795	$11.953
Laurel Run Plant (Nov., 1914-Oct., 1915—Total of 801.57 mil. gal. treated)						
*Max.	86.970	13.52	0.50	$0.222	$6.677	.....
Min.	17.480	5.54	0.21	0.091	1.609	.....
Av.	.....	7.83	0.29	0.128	1.950	$2.078

*Based on monthly averages.

The actual labor required to operate a chlorine plant is approximately 1 hr. per day, as the attendant at the reservoir is only required to read the gages, get the scale weight and change empty for full cylinders, when necessary, fix his fires morning and evening and make his report to the office each morning. The general care of the plants and clerical work is in charge of another man, who makes weekly inspections to insure constant operation of these machines. The general expense is for a portion of telephone charges, fuel and any repairs necessary. With the installation of the last three chlorine plants we will effect a saving of over 300 per cent, based on the cost of hypochlorite.

Colloidal Theories, Applied to Colored Water, Reduce Cost of Chemicals

Saving of 50 to 70 Per Cent Effected at Wilmington, N. C., in Treating Mixed Water of High Color and Turbidity

By GEORGE F. CATLETT
Chemist and Bacteriologist, Board of Health, Wilmington, N. C.

IN recent studies conducted for the improvement of the water supply at Wilmington, N. C., results have been obtained bearing upon the physical chemistry of coagulation. The laws relating to the chemistry of the colloids have been made use of with marked increase in efficiency and economy.

The raw water at Wilmington is pumped from the Cape Fear River, which forks just opposite the upper part of the town, the main river going in a northwesterly direction away from Wilmington, and the tributary, known as Northeast River, flowing northeasterly along the city front. The main river extends for a considerable distance into the interior of the state, and has a drainage area of 8400 sq. miles. It brings down a water high in turbidity and low in color, very similar to the Mississippi and its tributaries. The Northeast River, on the other hand, has a drainage area of only 1330 sq. miles, consisting of low ground, meadows and cypress swamps, which give to its water a very high color (150 to 300), with practically no turbidity.

Character of Raw Water

The water plant is situated just above the city, and just above the fork of the river, on the Northeast branch. The unusual and unique nature of the raw water is due to the fact that there is a mixture of both the high colored water and the high turbidity water, the one or the other predominating according to the tide changes four times a day or to freshets in either branch. Under usual conditions a high turbidity water cannot contain much color, as the turbidity will remove the color to a great extent if given time. In the present case the water is treated shortly after the mixture is made, and we have to deal with high color and high turbidity in the same water.

The river receives the sewage from Wilmington below the water intake, but has no polluting courses above. The high dilution makes the sewage pollution no great load for a filtration plant to take care of.

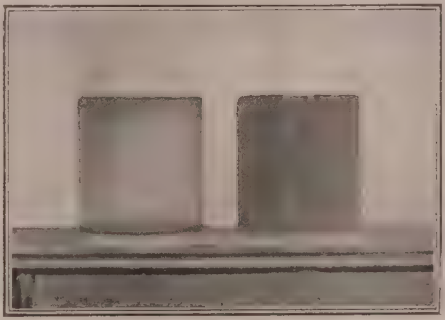
The filtration plant is of the ordinary mechanical type, consisting of eight units of 500,000 gal. each, with a reserve provision for four more units. Two coagulating basins are provided, giving a combined basin time of about 5 hr. When the plant was completed in 1911 these basins were independent of each other and only one could be operated at a time; with this arrangement only about 2½ to 3 hr. time was available. Besides, the most convenient basin had no baffling and, through "short cutting," much less than the theoretical basin time was obtained.

The chemicals used are 22 per cent alum, soda ash, and, recently, lime, the low alkalinity of the raw water requiring the addition of the latter. This alkalinity runs from 8 to 5 parts per million.

It may be seen that this was a "standard" plant, designed for an average water, and that no attempt was made to provide for the unusual demands of the Wilmington.

The results obtained were very unsatisfactory. The plant gave very satisfactory bacterial removal, but very poor removal of color and turbidity, and in addition it was impossible to prevent the coagulant from separating out in the mains from a colloidal state that would pass the filters. From 3 to 4 grains per gallon of alum were used, as better results were obtained than when using a smaller amount. The resulting carbon dioxide and bisulphate caused, with such a soft water, corrosion of plumbing, "red water" trouble and boiler action. This all caused great dissatisfaction among the water users, and the usual prejudice following the introduction of an alum-treated river water was augmented so that its effect will be felt for many years.

All of the usual remedies were tried. The alum was increased and decreased as high as 5 grains per gallon. The soda was decreased to a very slight excess, and the sand was thoroughly investigated, using various sizes. The washing was carefully studied to insure a proper film, and, finally, the basins were connected in tandem to increase the basin time.



SAME WATER (HIGH COLOR) TREATED WITH THE SAME AMOUNT OF ALUM

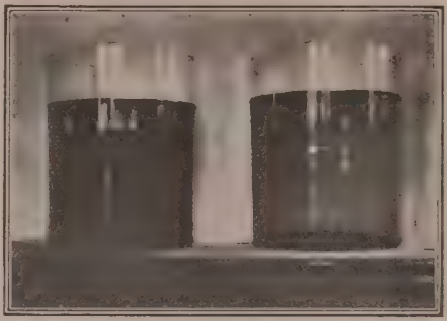
The jar on the left has dosage of alkalinity so as to leave alum slightly in excess. The other vessel has about 1 gr. per gallon excess alkalinity. Picture taken after 2 hours' standing. Note complete sedimentation in former, and very little in the latter.

Color and Turbidity

Turbidity consists of fine sand, silt and clay, a part of which is large in size and settles out without treatment, and a part of such finely divided material as to produce a colloidal suspensoid. It has been demonstrated that this is a negatively charged colloid.

The coloring matter in the water is chiefly tannates, gallates, etc., which are colloids or semi-colloids following the same laws. This is positively charged and is similar to aluminum hydrate in this respect.

In the treatment commonly used to remove these materials we introduce the sulphate of aluminum or of iron, and therefore have to consider these in studying the reactions taking place. These are soluble in water, are crystalloids, and have relation to the colloids only as electrolytes and colloid precipitants. When this material is introduced into the water containing alkali, they are immediately thrown out as aluminum or iron hydrate. This is precipitated in very finely divided particles, and these should be made to pass more or less rapidly by agglomeration through gradually decreasing degrees of dispersity until they have passed the colloidal stage and settle out readily from suspension. A most important feature of basin action is to prevent this material from remaining in the colloidal stage. When the precipitated materials settle down in a compact mass in water they partake of the nature of a gel.



SAME WATER (HIGH TURBIDITY)—NO COAGULANT ADDED

Vessel on left had sulphuric acid slightly in excess. On the right there is added hydrated lime to slight pink. on addition of phenolphthalein. After standing 48 hours.

In order to secure a full precipitation of these insoluble hydrates it is necessary to have in the water sufficient precipitating alkali to react with the aluminum and iron sulphates. This is found naturally in water in the form of the carbonates of lime and soda. Both the carbonate and bicarbonate of sodium are soluble, but the carbonate of lime is only very slightly soluble, and there must be sufficient carbon dioxide in the water to convert this into the bicarbonate before it will exist in solution. Some waters do not have sufficient natural alkalinity, and it is necessary to add additional alkali in the form of the carbonate of soda and lime hydrate. The added sodium carbonate, in reacting with the aluminum or iron sulphate, sets free carbon dioxide in the water. The lime hydrate, on the other hand, takes up the free carbon dioxide in the water and the half-bound carbon dioxide already in the water, so that the bicarbonate of lime already in the water is thrown down as carbonate together with the added lime.

The carbon dioxide derived from the soda reaction and that existing free in the water act as a negatively charged material on the colloids, and are important for this reason.

Principles of Colloidal Reactions

Colloids are mixtures of two substances which partake very strongly of the properties and actions of solutions, but, unlike true solutions, still preserve a distinct heterogeneity. Ordinary sand mixed with water does not result in a change of the properties of either the sand or the water. If, however, the sand be increased in the dispersity of its particles, we finally reach a stage where the sand and water mixture differs in important properties from the sand and the water. The high degree of dispersity increases the specific surface proportionately, so that the surface tension equalizes the force of gravity and keeps the sand particles in suspension in the water. These particles act in some respects like the ions of true solutions. Colloids are commonly formed of liquids and solids (suspensoids), and of two liquids (emulsoids). A liquid mobile colloid is known as a sol; a jellylike colloid, a gel.

The properties and actions of these colloids form a complex subject, and cannot be outlined even briefly in a discussion of this nature.

Colloids may be precipitated by (1) soluble crystalloids, or (2) mutual precipitation with other colloids. A positively charged colloid is thrown down in the presence of an anion—e. g., aluminum hydrate suspensoid is thrown down quickly if a few drops of sulphuric or hydrochloric acid are added. Certain salts also accomplish this precipitation, as in the case of sodium sulphate acting on aluminum hydrate suspensoid. The precipitating strength is proportional to the chemical valency, i. e., the valency of the ion group (anion against negative colloids, and cation against positive colloids) concerned.

The second interesting action is due to the mutual precipitation of two colloids of opposite electric charge; negatively charged clay particles and positively charged coloring matter react mutually.

The reverse of these actions is also true. Crystalloids, acids and bases, and other colloids of the same electrical charge act to support the colloidal state.

EXPERIMENTAL APPLICATION

A sample of the high colored, clear, Northeast River water, if kept for some time, will coagulate and deposit the coloring matter to a considerable extent. If the water is made slightly acid, this action is hastened. Before sewage pollution made it necessary to discontinue the practice, vessels before leaving the port of Wilmington to cross the Atlantic filled their water casks from this Northeast River. They reported that, after some time at sea, the color settled and the water was particularly good. There must have occurred a formation of carbon dioxide from the organic matter.

Large glass battery jars were filled with definite amounts of the high colored water (180-200), and aluminum sulphate and soda were added in such proportions that the aluminum sulphate was in slight and in large excess respectively on the one hand, and the soda in slight excess and in excess of 10 parts per million respectively on the other. Where the alum was in excess (slight) the efficiency of the flocculation and precipitation was markedly increased, and color removal effected in less time with considerably less alum. Where it was necessary to use 3½ grains of alum with the alkali in the ordinary excess of 10 parts per million, two grains accomplished the result even more satisfactorily, when the alkali added was only sufficient to allow the alum to be slightly in excess.

Similar jars were filled with a high turbidity water (160 turbidity—60 color). To one jar was added a small amount of lime. To another lime was added in excess (to complete neutralization of CO_2), and finally one with water just as it came from the river. The test with excess lime gave almost complete precipitation of the clay in a few hours, while the untreated water settled very slowly, and the acid test showed little change after several days.

When these tests were made on a higher colored water the coloring matter interfered with the action.

A deep well water with a high content of bicarbonate of lime (125 parts per million alkalinity) was also placed in the jars, and the laboratory turbidity standard suspension added to produce a turbidity of 200 parts per million. This also showed a marked precipitation of the turbidity when lime was added in excess. These were even better than the river water tests, as there was no color to interfere. The precipitating lime also aids the reaction.

PLANT APPLICATIONS

At the time these principles were applied to the Cape Fear River water the water was running with a color of 180 to 200 and with practically no turbidity on low tide. On high tide the color was 130 to 160, and the turbidity was 30 to 50. The alum used was 4 grains to the gallon and the soda was added to make an excess alkalinity of 10 parts per million. All of it was applied to the intake suction and the water pumped to the first basin, which was on a higher elevation than the other one. From there it flowed to the lower basin and thence to the filters. Results from the treatment, as previously stated, were highly unsatisfactory. Color and turbidity were incompletely removed, and colloidal coagulant passed through the filters and was precipitated out in the mains. All of the ordinary causes for this were thoroughly investigated.

The treatment was changed so that all alum was still applied to the pump suction, but just so much soda to allow an excess of alum of ¼ grain. The result was that the reaction in the first basin took place in the presence of excess alum, which has an opposite electrical charge to the aluminum hydrate, as well as in the presence of sodium sulphate and bisulphate. There is no appreciable absorption and loss of alum in this way by actual test. The water finally flowed to the second basin where it received additional soda to throw out the remaining alum, and to leave an excess alkalinity of 10 parts per million.

This arrangement showed just as good results as the laboratory tests indicated. It has been continued since March, 1915, with splendid improvement in the water and economy in treatment. Where previously the filtered water had a color (due to color and turbidity) of 40 to 100 parts per million, we now have a color of 0 to 5, with an infrequent maximum of 10 or 15. In addition, the amount of chemicals has been cut 50 to 70 per cent. The improvement has also been due to a later substitution of lime for part of the soda, thus reducing the carbon dioxide in the lower basin. A return to the old method in cleaning the basins always brings the former bad water.

OTHER TESTS MADE

Tests were also made, where the raw water happened to be low in color and high in turbidity, when all alkali was added in the form of lime to the upper basin and the alum put in the lower basin. Enough turbidity was removed in the upper basin to demonstrate the soundness of the principles involved, but there is always too much color to permit of good results. If a third basin were added, as is now being considered, it will be possible to effect the color removal in the first two basins as described, and remove the turbidity remaining by rational treatment in the third basin.

These principles have been applied only to the particular case of the Cape Fear River water, but they are applicable to this type of water which is prevalent on the Atlantic seaboard. It will be possible to obtain similar results on other types of water. Fortunately the work done on the Wilmington water is not the only exposition of the soundness of these principles in practice.

In the Engineering Record of Sept. 4, 1915, page 292, is a description of some results on the Neosho River water at Burlington, Kan. This is described as a high turbidity, low colored water. Trouble had been experienced from colloidal clay and from the coagulant persisting in colloidal suspension. The alum was applied in a quantity of more than 4 grains per gallon. This water was high in carbon dioxide and bicarbonate alkalinity, but by getting rid of the free CO_2 by whipping and churning the water and by neutralizing the half-bound CO_2 with lime hydrate, excellent results were obtained with much less alum. The results reported here are particularly interesting in respect to the good effect secured by treating the water with an excess of lime before any alum is added. This is in close harmony with the Wilmington results.

Elbert E. Lochridge, in *American Journal of Public Health* for November, 1914, describes a treatment of the high colored, low turbidity water at Springfield, Mass. Splendid results in improvement of the water, and reduction of the alum required, were obtained by adding the alum in excess to a basin partly filled with water, and then adding raw water to get the required excess alkalinity. This is interesting in illustrating how the excess alum treatment can be applied even though the alkalinity in the raw water is in excess of what is required.

CONCLUSION

The experiences at Wilmington are given in the hope that they will contribute toward more clearly establishing the fact that the chemistry of the colloids is the true foundation upon which all water clarification design should be based. One reason that the chemistry of the colloids has not received more attention in water purification is because only recently has the true action of these complex bodies been clearly understood. Until the appearance in 1915 of the book by W. W. Taylor, the "Chemistry of the Colloids," there was no work in English comprehensively treating the subject.

The large cities are able to employ the most eminent men in the profession, and study at considerable cost the peculiar needs of their particular water. In the case of the small plant we have ample illustration that the practice of "designing" a "standard" outfit, consisting of filter units furnished by the filter manufacturers, is altogether too common. Basins are calculated to give 3 to 6 hr. contact, with a few baffles put in with a vague idea of what actions they are meant to bring about. Chemicals are introduced in a haphazard manner. There is always a tendency by the "business man" councilman to judge that the small priced man is the proper one for a small plant, independent of the obstacles to be overcome.

It is on account of this that it would seem desirable to establish and define the principles involved in water purification on a rational basis. In this way only can the plant be designed so that the proper chemical reactions will be applied, and the equipment so arranged as to best perform this work.

Surveying Government Timber

A reconnaissance of all standing timber in the national forests of Oregon and Washington, involving about 25,000,000 acres, has recently been completed by the United States Forest Service. The examination has been classed as an "extensive" reconnaissance in contradistinction to the intensive surveys used where extremely accurate results are desired.

Brush and Riprap Buffer Will Protect Bulkhead

Creosoted Timber Wall Being Built at Stone Harbor, N. J., to Resist Heavy Seas, Will Be Supplemented by Crib Jetties

By HARRY E. WEIR
City Engineer, Wildwood, N. J.

A CREOSOTED bulkhead with a buffer in front of brush topped with riprap and held by a row of piles, and an overhanging lip to turn the waves outward, will form the backbone of the beach protection works being built at Stone Harbor, N. J. To help build up the beach jetties filled with brush and stone will be placed where deemed necessary. The form of construction is being patterned after one that withstood severe storms when surrounding works failed.

In December, 1914, several violent storms swept the entire south coast of New Jersey, doing severe damage at a number of points. At Ventnor a concrete wall was practically destroyed, and at Stone Harbor, which had no protection, the beach was lowered to a depth of 3 ft. and several houses on the front were destroyed. At Wildwood Crest the construction shown in the accompanying photograph, taken the day after one of the storms, suffered almost no damage. Consequently the borough council of Stone Harbor decided to build a similar wall, and the writer, who had charge of the construction of the wall at Wildwood Crest in 1908, was engaged to prepare plans and specifications for the protection works at Stone Harbor. The bulkhead wall will be supplemented by a series of jetties.

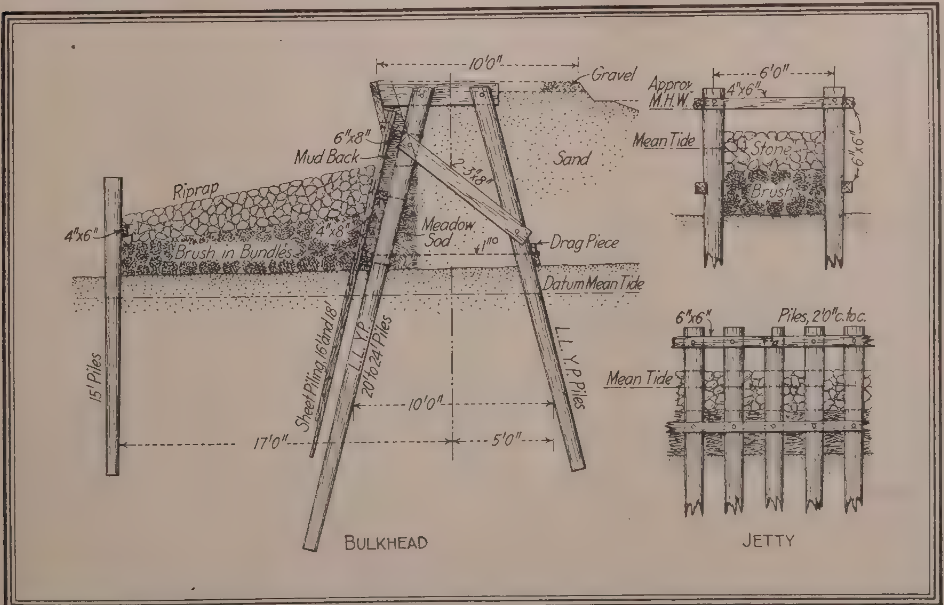
The wall when completed will be 8250 ft. long. The form of construction is indicated in one of the drawings. For the main structure piles are driven as shown, forming an A-truss construction with a double course sheathing on the water side of 4-in. planks. Twelve feet in front of the bulkhead is placed a row of toe piling, and between this piling and the bulkhead is an apron of tightly bound brush in bundles from 12 to 14 ft. long, on which is placed one-man and two-man stone. The amount of stone used is 1¼ tons per 10 ft. Meadow sod is placed back of the bulkhead to keep the sand from leaking through.

A feature of the bulkhead is the lip sheathing at the top, placed with a slight overhang so that the waves that break over the toe piling will be deflected outward, and will not fall behind the bulkhead and cause erosion. This is a very important detail of the construction.

There will be nine jetties, varying in length from 300 to 400 ft. Their form of construction is shown. In profile the tops of the piles at the outer ends will be 3 ft. above mean tide, or about 1 ft. above mean high water, for a distance of about 150 ft., after which they will be on an ascending grade to the elevation of the toe piling of the bulkhead, which is 5 ft. above mean high water. The purpose of the jetties is to help build up the beach and also to break up the waves.

THIS WALL AT WILDWOOD CREST HAS WITHSTOOD STORMS SINCE 1908

The contractor for this work is the Hill Dredging Company. The approximate price per foot of bulkhead and apron is $15 per linear foot. The cost of the bulkhead wall at Wildwood Crest was approximately $8 per foot. The difference in cost is due to the fact that all the material at Stone Harbor is creosoted in order to withstand the teredo, and because the new wall is of much heavier construction than the old, using fifty per cent more lumber.



DETAILS OF BULKHEAD, AND SECTIONS AND PART ELEVATION OF JETTY
Note overhanging lip at top of bulkhead.

Rolling Important for Asphalt-Gravel Roads

A. P. Rice Indicates Requirements for Satisfactory Job on This Class of Road and Describes Construction Methods

THAT skillful rolling is an important feature of asphalt-gravel road surfacing was strongly emphasized by A. P. Rice in a paper presented at the March convention of the Massachusetts Highway Commission. Others in attendance concurred with Mr. Rice's view and offered many suggestions for carrying on that part of the work. Other conclusions reached were that the money spent on asphalt gravel surfaces is absolutely wasted unless the subgrade is thoroughly drained and approximately true to section; that less trouble from crawling of the surfacing material, which results during rolling, is experienced where enough dust or sand is used for binding to keep the larger stone in place; that running the mixer too long is apt to result in the formation of balls in the finer part of the aggregate, and that the stone base offers the least difficulty in attaining proper grades and cheaper sections.

ROLLING

As a rule for determining when the heat of the surface is suitable for rolling it was stated that the temperature was proper if the mixture was not too hot for the hand to be rested on for half a minute. During the rolling the end of each strip should be staggered, and the direction of the roller should be reversed as rapidly as possible, but without jerking. Each day's work should be thoroughly cross-rolled.

Better joints result if the work is ended and started transversely, and if the joint is ironed out with one wheel of the roller as soon as possible.

HANDLING THE MATERIAL

Normally 3 min. should be sufficient to mix gravel and asphalt, the latter being heated to 200 to 300 deg. Fahr. No material should be spread on a wet subgrade. The use of a horse-drawn roller was favored in connection with a steam-driven outfit in handling material just spread. If depressions are overlooked until the mixture is cold, the old material should be cut out in the immediate locality, the edges of the cut painted with hot oil and the new mixture rammed in and rolled to a true surface.

It has been found that the stone base is the least difficult to bring to proper grade and cheaper section. Less trouble from the crawling of surfacing material, which results in cracks during rolling, is experienced where there is enough dust used for binding to keep the larger stones in place, all the binding material being slightly below the surface of the stone. In taking up pieces of surfacing that had crawled and cracked a layer of dust on the surface of the stone, which seemed to act like flour on a bread-board, was found. Brooming the surface of the broken stone base just ahead of the asphalt is advisable and incurs little extra expense to the contractor.

Unless the subgrade is thoroughly drained and approximately true to section the cost of putting on a gravel asphalt surface is wasted. In view of the traffic which passes over the roads during its construction it had not been found possible to put a broken-stone foundation in place and keep it there without the use of water. All irregularities of surface must be corrected in the base, otherwise a smooth surface of asphalt cannot be laid. In later contracts for this class of work in Massachusetts, payments have been made on the basis of materials used and not by the area laid.

Railroad Revenues Continue Favorable Showing in March

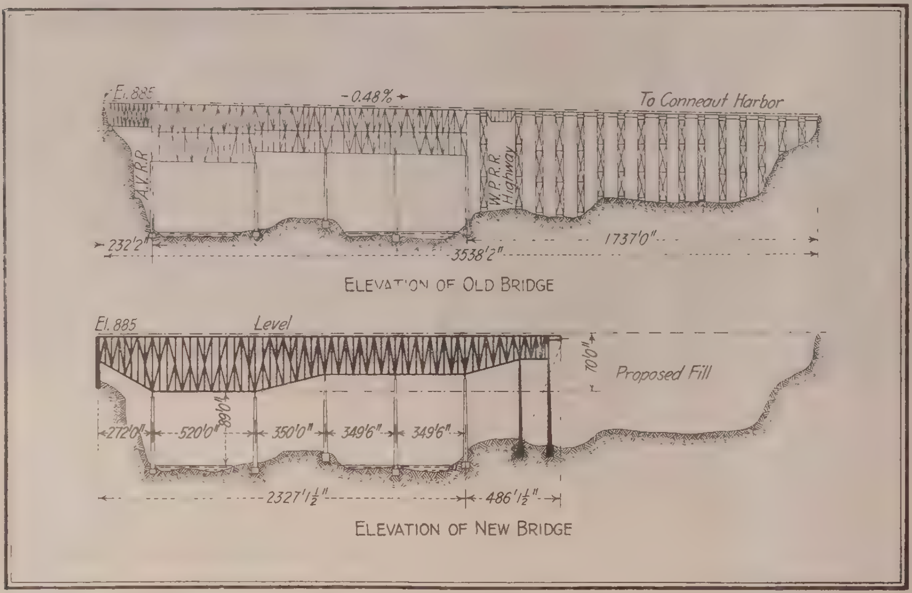
Gross operating revenues for March on the large steam railroads of the United States, according to a bulletin issued by the Bureau of Railway Economics, were $1,260 per mile, showing an increase of $245, or 24.1 per cent, as compared with March, 1915. Operating expenses were $844, an increase of $122, or 16.8 per cent. Net operating revenue, therefore, was $416—an increase of $123, or 41.9 per cent, and operating income was $362—an increase of $118, or 48.4 per cent. The operating ratio was 67.0 per cent, as compared with 71.7 per cent in March, 1915, and 73.4 per cent in March, 1914. Considering the three main districts, the respective ratios for March, 1916, and March, 1915, were as follows: Eastern, 70.0 and 74.4; Southern, 64.5 and 70.2; Western, 64.5 and 68.2.

Begins Reconstruction of Allegheny River Bridge

In Double-Tracking High Crossing Bessemer & Lake Erie Will Put in New Level Spans and Fill Long Viaduct Approach

WORK has been started on the replacing of the single-track bridge of the Bessemeh & Lake Erie Railroad over the Allegheny River 14 miles north of Pittsburgh by a double-track structure. The provement was authorized Feb. 1, and the contracts, both for the substructural work and for the steel work and its erection, have awarded.

The accompanying drawing shows on a distorted scale the elevations of the old bridge and the new. The bridge crosses the river proper on four main spans, aggregating 1569 ft. in length. On the south bank of the river, which is steep, is the Allegheny Valley Railroad, and on the north bank is the West Penn Railroad and a highway, beyond which is a 1500-ft. steel viaduct across the flat. The bridge descends on a 0.48-per cent grade. The height of the bridge above low water is about 160 ft., and the height of the trestle approach is about 120 ft.



ELEVATION OF OLD BRIDGE

ELEVATION OF NEW BRIDGE

DISTORTED ELEVATIONS OF THE NEW BRIDGE AND THE OLD

The new bridge will be brought up to level, the south end being at the same elevation as the old, but the north end of what is now the viaduct approach being 17 ft. higher. The masonry piers, the foundations for which were laid for two tracks when the bridge was built, will be brought on up, the extensions to the west being about 35 ft. Two new piers and an abutment will be required as shown. The new double-track superstructure will be erected on the new masonry without interfering with the present bridge, after which the present bridge will be removed and the new superstructure centered on the piers.

NORTH APPROACH TO BE FILLED

The entire viaduct approach north of the West Penn Railroad and the highway will be filled with steel-mill refuse, which the Bessemer & Lake Erie uses for all of its large embankments, having from 100 to 150 cars of this material to dispose of daily when the steel mills are in full operation. The embankment will take about 1,200,000 cu. yd. To place it without interfering with the heavy traffic on the present single-track bridge a steel viaduct 1545 ft. long and 155 ft. high across Bull Creek, 9 miles to the north, which has been put out of use by a grade revision, is being taken down and will be re-erected alongside the present viaduct approach. The transplanted viaduct will be buried in the embankment.

The work is being done under the direction of the Bessemer & Lake Erie Railroad, of which H. T. Porter is chief engineer, and W. H. Slifer, resident engineer. The Arthur McMullen Company of New York City, has the contract for the masonry, and the American Bridge Company will furnish the steel and erect it. The latter company is also taking down the Bull Creek viaduct and will re-erect it at the Allegheny bridge site.

Waterbound Macadam Tar-Surfaced Stands Heavy Traffic

Bronx Borough, New York City, Keeps Street Under City Traffic in Excellent Condition for 2 3/5 Cents Per Square Yard

THAT waterbound macadam if properly surfaced—which can be done economically—will stand up well under heavy motor traffic is proved by the experience of the Borough of the Bronx, New York City, which maintains 1,800,000 sq. yd. of such pavement at a cost as low as 2 3/5 cents per square yard in one heavy-traffic street and 3 1/5 cents per square yard in other streets.

GRAND CONCOURSE

The most striking example is the Grand Concourse and Boulevard. This pavement, which is 4½ miles long, has two 35-ft. roadways and contains 192,000 sq. yd. of surface. According to an informal count it has carried as many as 1200 vehicles an hour. It is a main driveway, leading to the parkways and suburban counties to the north, and carries regularly a heavy, and, at times, high-speed traffic. Heavy trucks frequent it. Though the proportion of this class of traffic is not large as compared to other streets in the Bronx, it does amount to more than the average hard-surfaced country road has to carry.

The original surface treatment of the Concourse consisted of a ¼-in. thickness of Tarvia A and grit. The tar treatment was applied hot in the proportion of 1/3 gal. to the square yard by a squegee, though the highway officials state that if they had to do it over again they would use a pressure distributor. The cost of the first application was 8 cents per square yard, due to the fact that it was thoroughly cleaned and the dust film entirely removed before the bituminous material was applied. The extreme thoroughness of the cleaning was considered justified in order to secure a satisfactory bond between the metal of the road and the bituminous surface.

Every spring a gang goes over the roadway and using tar makes whatever patches may be required. When the warm weather comes a paint coat of Tarvia B and grit is applied. This is the only maintenance on the road throughout the year. The aim is to keep the top surface thin.

MAINTENANCE ON OTHER STREETS

The maintenance on other waterbound streets in the borough is similar to that on the Concourse. Some of them do not require repairs annually, but are sometimes allowed to go over until the next spring. Those on a grade appear to require less repair than those under similar traffic on level stretches. The quantity of bituminous material applied varies from 1/6 to ¼ of a gallon per square yard, according as the appearance of the road indicates the need of a greater or less quantity.

John P. Binzen, engineer of maintenance, highways and sewers of the borough, is in direct charge of all repair work. J. Stewart Wilson is superintendent of highways and R. H. Gillespie is chief engineer of highways and sewers.

How Steel Prices Affect Cost of Minnesota Bridge Work

THE ADVANCE during the year ended March 30 last of 1.4 cents per pound in the price of structural and reinforcing steel has, according to the Minnesota State Highway Commission, resulted in increasing the cost of various types of bridge superstructure used in that state, as follows:

STEEL BRIDGES WITH CONCRETE FLOORS	
15-ft. beam span	$62.16
18-ft. beam span	78.90
23-ft. beam span	112.46
30-ft. beam span	180.84
40-ft. low truss	275.46
55-ft. low truss	412.56
80-ft. low truss	723.06
120-ft. high truss	1,195.11
160-ft. high truss	1,910.21
REINFORCED-CONCRETE BRIDGES	
15-ft. slab span	$22.96
18-ft. slab span	30.83
23-ft. slab span	50.98
30-ft. deck girder	82.93
40-ft. deck girder	134.05
55-ft. deck girder	206.64

In addition to these increases the same advance in price makes the average cost $50 greater for reinforced-concrete abutments used with I-beam spans and reinforced-concrete slab spans. The average abutments used with truss and concrete girder bridges are higher than those used with the shorter spans and contain approximately twice the amount of reinforcing steel, so that the advance in cost would be about $100 for each abutment.

These increases mean that a 40-ft. truss costs 32 per cent more this year than last, and that a 40-ft. deck-girder reinforced-concrete superstructure costs 15 per cent more.

The commission points out that the average cost of new concrete-floored bridges built on its plans has been approximately $1 per foot per year, and that, as the cost only of replanking the floor of an old bridge is about the same amount, it is not a good investment to put extensive repairs on old bridges even with the present increased cost of new construction.

Rising Gate Guides Reduce Span Length

Intermediate Submerged Piers Support Movable Gate Posts Giving 52-Foot Clear Span for Passage of Debris and Ice

WIDE spillway openings free from any lifting equipment which would impede the passage of driftwood or ice during flood flows, are obtained at Merrill, Wis., by movable guides which are pulled up after the gates have been raised. The dam is opposite the city and close to the business center, but the Merrill Railway & Light Company, owner of the dam, desired to keep the pond level at as high a stage as possible. When let down the built-up structural steel guides fit into steel-lined slots in the submerged concrete piers, thereby cutting the unsupported length of the gate into four equal parts of 11 ft. 7 in. each.

HOME-MADE CARS DISTRIBUTED CONCRETE

The piers are 2 ft. wide and rise 5 ft. high above the old crib dam, which was filled in with concrete. The gates raise the water 7 ft.; that is, 2 ft. above the tops of the piers. Both upstream and downstream slopes of these small piers are 1.84:1. To take the shock of floating débris the face of the slope is reinforced with a 10-in. I-beam embedded flat and anchored to the concrete with ⅝ x 18-in. bolts.

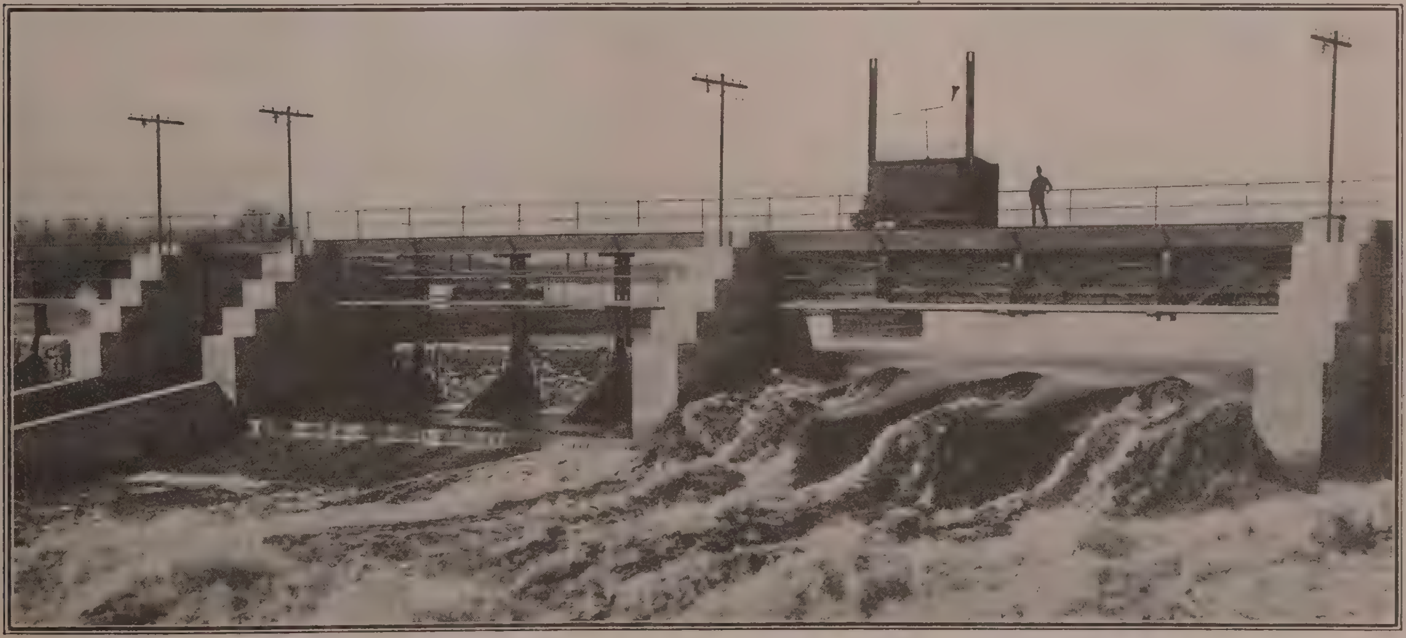
At the intermediate piers the steel gates slide in a movable 10-in. channel which in turn slides against a plate with out-turned angles, making a second guide. The plate extends only to the top of the pier, the upper end of the channel sliding in a similar guide suspended from an overhead trussed bridge of 24-in. I-beams. The electric gate hoist operates over this bridge, which is paralleled by concrete sidewalks on each side; one on the upstream side at the level of the top of the I-beams supported on the end piers and on brackets, and the other on the downstream side suspended from brackets 5 ft. below the bottom of the 24-in. I-beams, and from the hanger guide.

CRIBS ON ROCK SUPPORTED COFFERDAM

The work was carried out by company forces under the direction of H. L. Lange, construction engineer for the Merrill Railway & Lighting Company, for whom E. S. King is secretary.

A Billion Feet of Lumber from California

A total of more than a billion feet of lumber was sawed by California mills during 1915, according to statistics compiled by the U. S. Forest Service. The report includes figures from 136 mills, thirty-five of which had cut 90 per cent of the total. Of thirteen kinds of wood sawn, redwood led with a total of 418,824,000 ft. b.m. With the exception of about 1,000,000 ft. b.m., it was all California timber.


SECTIONS OF THE GATE CAN BE LIFTED CLEAR TO PERMIT THE PASSAGE OF FLOATING DEBRIS

Attain Artistic Effects in Chicago Park Buildings

In New Field Houses the South Park Commissioners Use a Dry Concrete of Small Aggregate Tamped Into Molded Forms

REMARKABLY artistic effects have been attained in two groups of park recreation buildings of concrete now near completion in Chicago. The unique feature of their construction is the rough surface in which fluted pilasters and a wide ornamental cornice of classic Doric design have been cast without showing the impressions of the forms. This gives the entire exterior walls a monolithic effect of pleasing and harmonious appearance. The horizontal markings shown in the photograph are not form marks, but are due to the method of laying the concrete entirely around the building in thin layers. In fact, the form boards were laid vertically. This type of concrete construction was first introduced in Chicago park work ten years ago by D. H. Burnham, architect.

BUILDINGS UNUSUALLY COMPLETE IN EQUIPMENT

These groups of buildings are located in what are designated as parks 15 and 16, each designed as a recreation and social center for a community of the city. Park 15 is bounded by Seventy-sixth and Seventy-eighth Streets, and Dobson and Ingleside Avenues; it contains 10.16 acres and has been named Grand Crossing Park. Park 16 lies between 103rd and 105th Streets and Oglesby and Bensely Avenues, and contains 18.52 acres, but at present is known only by the number. The two groups of structures in the two parks are of the same general dimensions and design, and a description of the buildings in Grand Crossing Park will therefore present the construction features of interest in both.

The main group of buildings is of cruciform shape, the length of which, not counting a cement platform, is 310 ft. The width of the central portion is 146 ft. 6 in. The buildings are more complete in equipment than has previously been attempted in city park structures. They are two-story and contain gymnasium and apparatus rooms for men and women, and an assembly hall. The roof is carried by open construction, steel trusses supporting wood purlins and rafters, the entire structure being roofed with green Spanish tile.

SWIMMING POOL

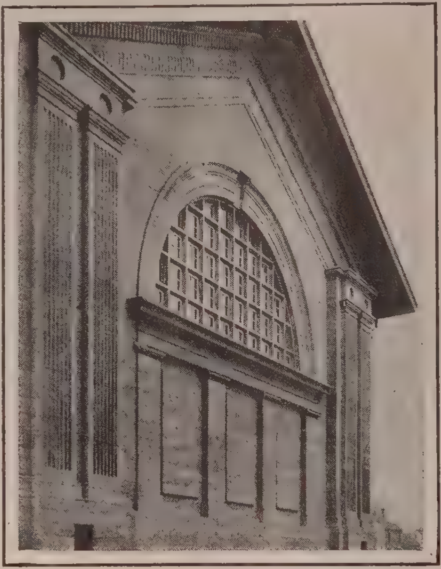
At the end of the main group of buildings in the rear of the men's gymnasium are a large open-air swimming pool, a power house and a service yard. The pool is surrounded by an ornamental brick and concrete walk with long concrete benches, and is connected with the lockers and dressing-rooms in the main group of buildings by asphalt walks on both sides. The pool is 130 ft. long by 60 ft. wide and is divided into two sections. The shallow end is 60 x 80 ft. and is designed for a water depth of 2 ft. at one end and 4½ ft. at the other. The deep end of the pool is designed for a uniform water depth of 8 ft. The walls and entire floor of the pool are faced with white enameled tile.

The power house is 52 x 65 ft. and is of the same rough surface ornamental concrete design as the other buildings. A feature of the power house is a chimney 115 ft. high with the same surface finish as the buildings, this being the first use of this construction in a chimney.

HOW CONCRETE EFFECTS WERE OBTAINED

The standard thickness of the walls of these buildings, not considering pilasters and cornice, is 18 in. This is composed of a 4-in. tile center with 7 in. of dry-mixed concrete on the outside and 7 in. of wet-mixed concrete on the inside. The dry-mixed concrete is composed of 2 parts cement, 3 parts torpedo sand and 9 parts ½ to ¼-in. stone. The interior side of the wall is composed of ordinary wet-mixed 1:3:6 concrete.

The walls were built in 8-in. layers, the tile being laid first, then the surface concrete, and lastly the wet-mixed concrete on the inside of the wall. In the placing of the surface concrete it was tamped very hard for a width of about 5 in. next to the tile and very little at the front. By the use of very small stone of nearly uniform size and a dry mix tamped in this manner it was possible to crowd the concrete forward into the molded design of the forms, bringing out every detail of the design and presenting a uniform rough exterior finish. In mixing the concrete for the surface only about one-third as much water was used as for the wet-mixed interior part of the wall.



MOLD MONOLITHIC CONCRETE INTO DORIC DESIGNS

STONE MUST BE SMALL AND UNIFORM

The inspectors of the South Park Commissioners say that the artistic results obtained by placing concrete in this manner require a uniform small size of stone, great care in securing evenly mixed concrete of uniform moisture and skill in tamping to crowd the concrete forward into the molded design of the forms. All concrete used in this group of buildings was mixed in a Standard low-charging mixer placed on the ground level about the center, close to the side of the main group of buildings. Most of the concrete was delivered in barrows from this position.

These buildings were designed and their erection supervised entirely by the engineering department of the South Park Commissioners under the direction of Linn White, chief engineer. J. D. Barber, assistant engineer, was in immediate charge of the work. The general contract was handled by the John Brittain Company, Chicago.

Highway Bridge Floor Is Light and Durable

Original Plank Floors Being Replaced by 2 x 4-Inch Joist on Recommendation of New York State Commission of Highways

By EMERY E. BRANDOW
First Assistant Engineer, New York Commission of Highways, Albany, N. Y.

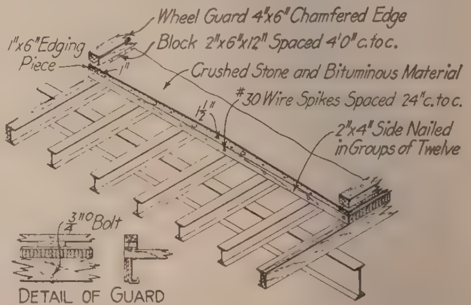
THE TOWNS of the state of New York have many light truss bridges which were originally designed for plank floors. The cost of upkeep on these floors is very great, and the danger caused by broken planks must always be considered. The live load which they are called upon to withstand at the present time is larger than ever before, due to the great number of motor trucks and road rollers now so common. The metal of the bridge has not always had proper attention, and the result is that in the majority of cases there is not sufficient metal to carry the present live loads and at the same time permit the use of a concrete slab floor.

As a money saver, and also as a means of causing less inconvenience to the traveling public, the Bureau of Town Highways of the State Commission of Highways is recommending the use of 2 x 4-in. joists in place of ordinary plank. The drawing herewith shows the method of placing this solid flooring, and the surface finish. Creosoted joists, of course, furnish the most ideal floors, and these are used in some cases, a treatment similar to that given wood blocks being applied. The state is required to maintain the floors of bridges in Indian reservations, where many thousands of feet of this lumber are used.

TIMBER TREATED WHILE LAYING

In order to lower the cost and at the same time keep the money for labor and supplies at home, many of the towns are providing their own treatment while actually laying the floor. Ordinary 2 x 4-in. stock is used, and is dipped in hot tar or asphalt and then allowed to drain before placing. If the wood contains much moisture or sap no treatment is given the bottom, this surface being left free for the escape of moisture or sap, which is believed to prevent rot. The joists are spiked together in blocks of ten or twelve and those blocks are toe-nailed at their ends. This is to facilitate the removal of any joint when necessary, as only a small number of the adjoining joists have to be disturbed.

Over the top surface is placed a heavy coat of hot tar or asphalt, and on this as a blotter is spread some crusher screenings or sand and gravel; some provide a thicker coat, using crushed stone, but this adds largely to the dead load. This makes a wearing surface and at the same time waterproofs the floor. This surface should be


Wheel Guard 4"x6" Chamfered Edge
Block 2"x6"x12" Spaced 4'0" c. to c.
1"x6" Edging Piece
1"
Crushed Stone and Bituminous Material
#30 Wire Spikes Spaced 24" c. to c.
1½"
2"x4" Side Nailed in Groups of Twelve
¾" ⌀ Bolt
DETAIL OF GUARD

TIMBER JOISTS FORM LIGHT BRIDGE FLOOR

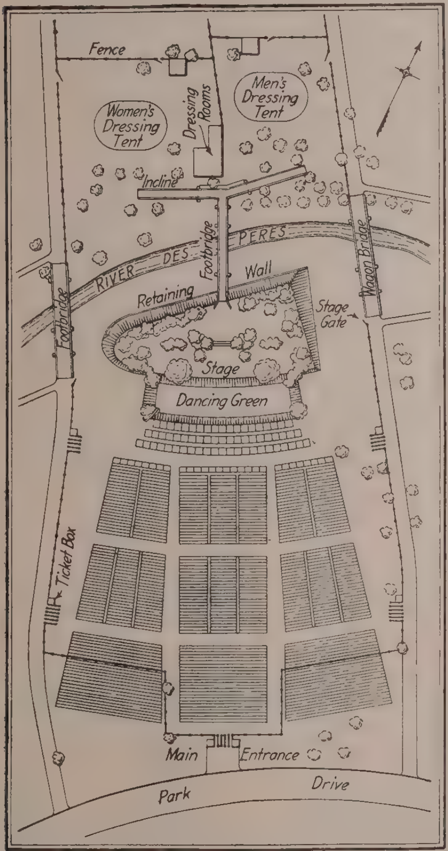
carefully preserved, but its cost of upkeep is very small.

Some of these floors have been in use for five seasons. One in particular, which is on the state highway leading down the Mohawk River just outside of the city of Utica, is heavily traveled, and yet to-day, after five seasons, is in first-class condition. On this same bridge, before providing this type of floor, the oak plank had to be entirely renewed every year, in addition to some extra attention from time to time. All of the results obtained to date favor this type of floor for light truss designs.

Small-Scale Structures Built for St. Louis Pageant

Temporary Stage Constructed on a 10-Foot Fill—Seats for 10,000 People Provided by Relatively Small Amount of Grading

NEW FIELDS for engineering work on a relatively small scale are seen in the increasing number of outdoor pageants in various large cities of the country. The community production of "As You Like-It" to be given in St. Louis on June 5 to 11 on a temporary stage erected in the center of Forest Park furnishes examples of the kind of engineering work involved. A relatively small amount of grading on a natural hillside has provided seats for 10,000 people. Three timber bridges have been constructed across the River Des Peres and a timber retaining wall has been erected for the fill under the stage.



PLAN SHOWS THREE NEW BRIDGES, RETAINING WALL, STAGE AND SEATING CAPACITY

GENERAL LAYOUT

The hillside selected furnished natural advantages in a gradual slope and the presence of two large trees, to form the proscenium of the open-air theater, as shown in the picture. Between and behind these trees the stage was built on an 8 or 10-ft. fill alongside the River Des Peres. Three bridges over this river had to be constructed, one 6 ft. wide between the dressing rooms and the stage, and two 12 ft. wide each and west of the stage to accommodate foot and wagon traffic, as seen in the accompanying plan. In front of the stage is a slope of about 4 ft. down to a dancing green which will accommodate about 250 people.

The 4-ft. timber retaining wall is anchored back by steel rods hooked around short posts, as shown in one of the drawings herewith. The fill retained by this wall supports the stage, which is more than 60 ft. deep at the center line and footbridge, and more than 150 ft. wide near the center, although only about 70 ft. wide in front between the two large trees.

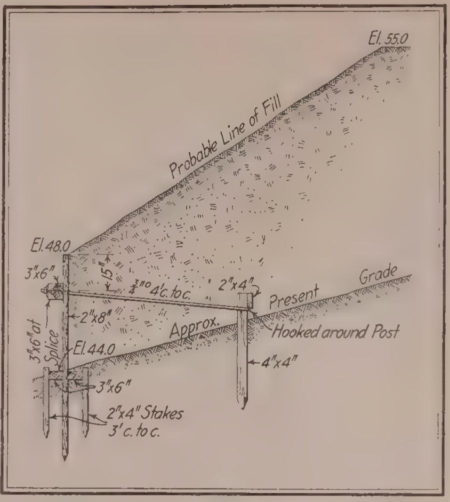
SITE OF STAGE FOR PAGEANT DRAMA

TIMBER BRIDGES

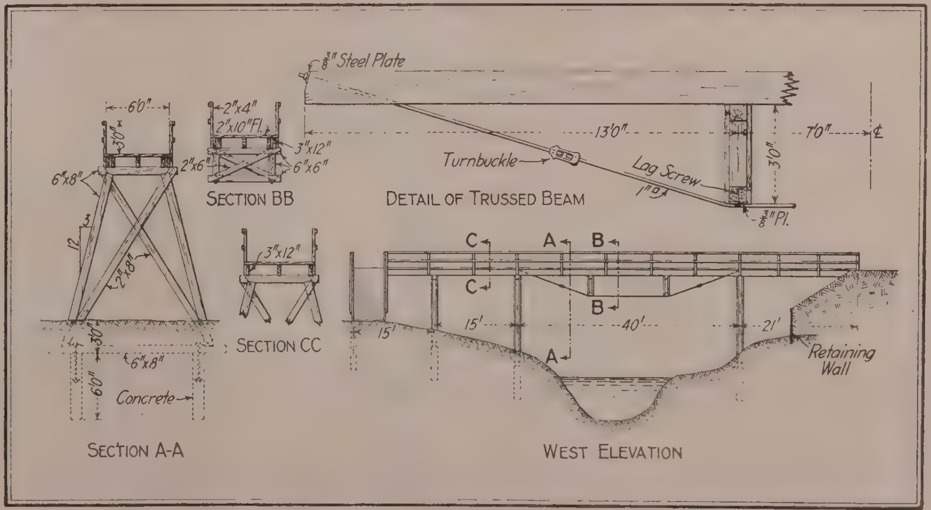
Trussed timber beam bridges of 40-ft. span are used for each of the three crossings provided over the river, with timber beam bents and approaches, and inclines at one end of the footbridge 6 ft. wide on the center line of the stage. Typical details of this construction are indicated by the accompanying drawings of this bridge. The other two are similar except in the use of three trussed beams in each case instead of two, with wider timber bents of similar standard construction, and 1¼-in. truss rods for the wagon bridge.

Concrete pedestals, four under each timber bent for the 12-ft. bridges and two as shown for the 6-ft. bridges, are 6 ft. high in all cases.

The work was done under the supervision of Nelson Cunliff, commissioner of parks and recreation, City of St. Louis.



DETAILS OF TIMBER RETAINING WALL



ELEVATION OF FOOTBRIDGE LEADING TO STAGE—DETAILS OF TRUSSED BEAM

Gives Cost of Concrete Lining Laterals on Average Job

TWENTY-TWO miles of laterals on the Orland project in California in sections ranging from a few feet to 8800 ft. in length have been lined with 1½ in. of 1:3:5 concrete. The work has no unusual conditions, so that the costs are representative average figures. Bottom widths varied from 2 to 8 ft. and slopes from 1:1 to 2:1. Not all laterals received lining, but in general it was placed in all fills; within highway boundaries to increase carrying capacity and to reduce maintenance; in sections of excessive seepage; as a protection over culverts and on curves, and also at forks of laterals where the number of structures made cleaning difficult.

For the longer stretches of work a portable 4-ft. mixer was used, but for the shorter laterals hand-mixing was employed. Bank-run gravel was obtained at a round-trip haul of 5 miles, cement at 6 miles, while water sufficient for the concrete work followed the lining crew down the lateral. According to a statement by A. N. Burch, project manager, in the *Reclamation Record*, there was little difference in cost between hand-mixed and machine-mixed concrete, but the machine-mixed product was better in quality. He has estimated the expense of the work, a typical example of its kind, as in the accompanying table.

Cost in Cents per Square Yard for Lining Laterals

Cement delivered on work	9.57
Gravel delivered on work	4.08
Mixing concrete	3.14
Placing concrete	2.94
Sprinkling and protecting	0.46
Preparing section for lining	6.97
Field superintendence and engineering	0.10
Maintenance of equipment	0.22
Plant arbitrary	0.43
Total labor and material	27.91
General expense	6.39
Total cost	34.30

Foremen and finishers were paid $3.20 per day, laborers $2.50, and teamsters with teams $4.50 to $5 per day. Cement cost $2 per barrel and gravel $1 per cubic yard. The total area of the lateral lining was 191,400 sq. yd.

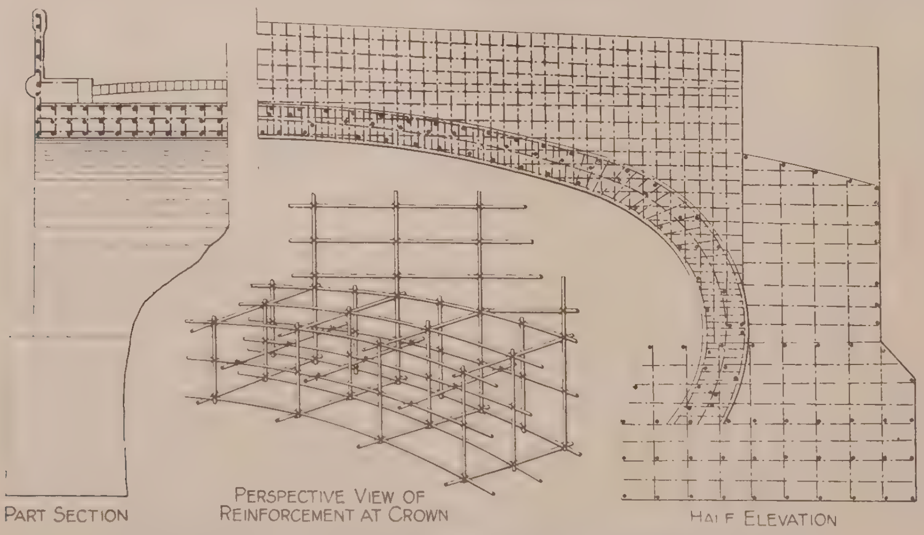
Double Reinforcement in Monier Arch Patent

Statement Made in Previous Article in Reference to Single Layer of Wire Netting at Intrados Was in Error

ATTENTION has been called to certain misleading statements regarding the Monier system of arch reinforcement which occur in the short historical sketch of arch patents printed in the Engineering Record of Feb. 26, page 274. It was there stated that "the genuine Monier system had only one wire netting at the intrados of the arch, and no sample has been found of two complete wire nettings used in the Monier bridges."

The Monier arch patent issued in 1873, as is indicated by the accompanying sketch taken from the original illustration, did cover the use of two or more layers of reinforcing steel rods for bridges. The description accompanying the supplementary patent of 1873 distinctly states that for small arches two rows of the reinforcing grillage would be used in the arch, while for larger arches carrying heavy loads, three or four rows would be used, such as shown in the drawing reproduced herewith.

The statement often made, and quoted in the article above mentioned, to the effect that the Monier system consists of reinforcement with wire mesh too small to be used with concrete is quite evidently not the case, when judged by the intent of the patent as shown by the drawing. The Monier patent as issued in France covers construction using either cement mortar or concrete.



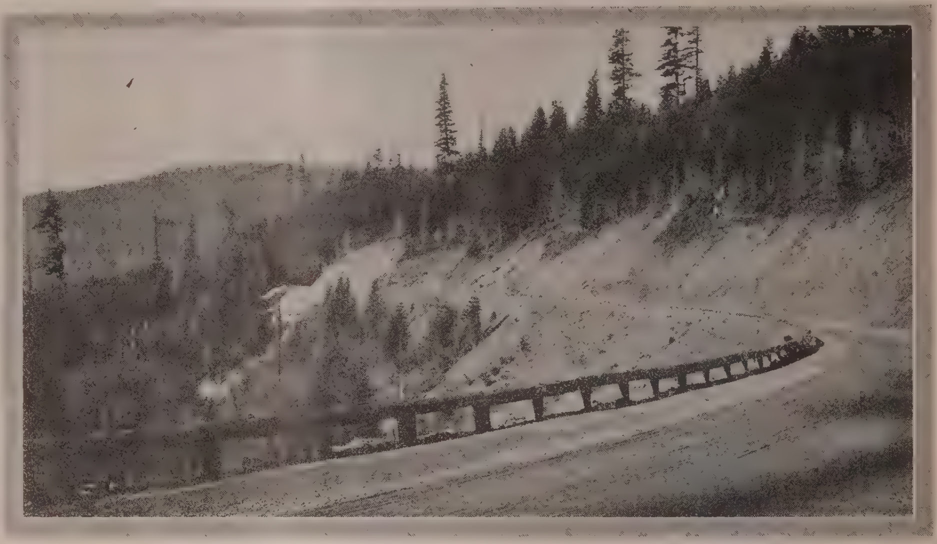
MONIER PATENT FOR ARCH REINFORCEMENT PLACED IN MORE THAN ONE ROW

Rustic Guard Rail Protects Highways in Washington

IN THE mountainous highway construction necessary in King County, Washington, it is deemed advisable to use a guard rail on all curves and grades. The standard type shown in the picture has therefore been adopted, involving the use of fresh cut timber which can always be found in that county adjacent to the line if not actually on the right-of-way.

The specifications for this construction call for 6-ft. posts, preferably cedar, 10 in. in diameter at one end and not less than 6 in. in diameter at the other end. They are set on 8-ft. centers, 3½ ft. in the ground, leaving a 30-in. projection. The guard rails proper are to be not less than 16 ft. long and from 10 to 14 in. in diameter. The rails are drifted to the posts with ¾-in. bolts, 20 in. long. It has been found that this construction costs between 20 and 25 cents per linear foot in place.

The work shown in the illustration was done under the direction of A. P. Denton, county engineer, King County, Washington.



GUARD RAIL BUILT FROM TIMBER ON OR NEAR RIGHT-OF-WAY

Test Douglas-Fir Ties for Holding Force of Spikes

THE GREATEST holding power of common spikes driven into untreated Douglas-fir ties was obtained when the spike was driven into a ⅜-in. hole. Under this condition an average force of 4627 lb. was required for removal. The holding power of common spikes driven into treated specimens reached the maximum average of 4474 lb. when the spikes were driven into ½-in. holes bored before the ties were subjected to the creosoting process. Screw spikes driven into ⅝-in. holes were removed from treated ties by an average force of 10,182 lb., which was 1215 lb. greater than that required for the pulling of screw spikes from the natural wood.

These conclusions are some of the results obtained from the tests of eighteen commercial-grade Douglas-fir ties recently conducted by the U. S. Forest Service, and published by the Association of Creosoting Companies of the Pacific Coast, to determine the holding force of spikes under various conditions in natural and creosoted timber. The specimens were cut in halves and various size holes were bored, after which half of each original specimen was subjected to a creosoting process involving boiling under vacuum, and the comparative holding values of spikes were accurately determined.

For common spikes driven into natural wood, the average holding force was found to be 4555 lb., while a force of 4160 lb. was the average required for the removal of the spikes from the treated specimens. The average force required to pull common spikes from the untreated specimens was found to be 4507 lbs. when the spike was driven into a 7/16-in. hole, 4115 lb. for a ½-in. hole and 3646 lb. for a 9/16-in. hole, while, for the treated ties, the average holding force of the common spikes was 4298 lb. when driven into a ⅜-in. hole, 4352 lb. for a 7/16-in. hole and 3778 lb. for a 9/16-in. hole.

The tests indicate that if the holes are not too large and the spikes follow the holes closely the resistance to withdrawal will usually be increased. Spikes driven close to but not in the holes have a comparatively low resistance. As would be expected, driving spikes in holes reduces the splitting and fiber-breaking to a considerable degree.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

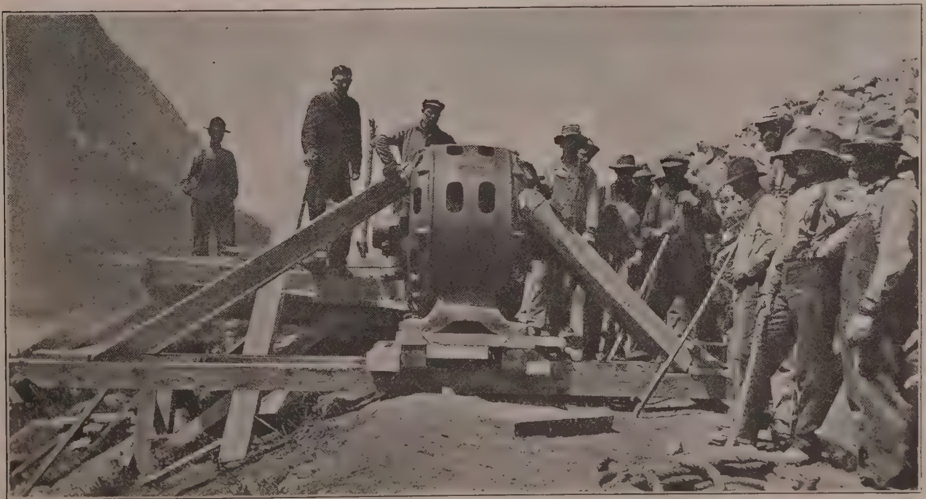
Special Skids Take 7-Ton Generators Down Side of Gorge

By F. N. BIERSACH
Erection Superintendent, Allis-Chalmers Company, Milwaukee, Wis.

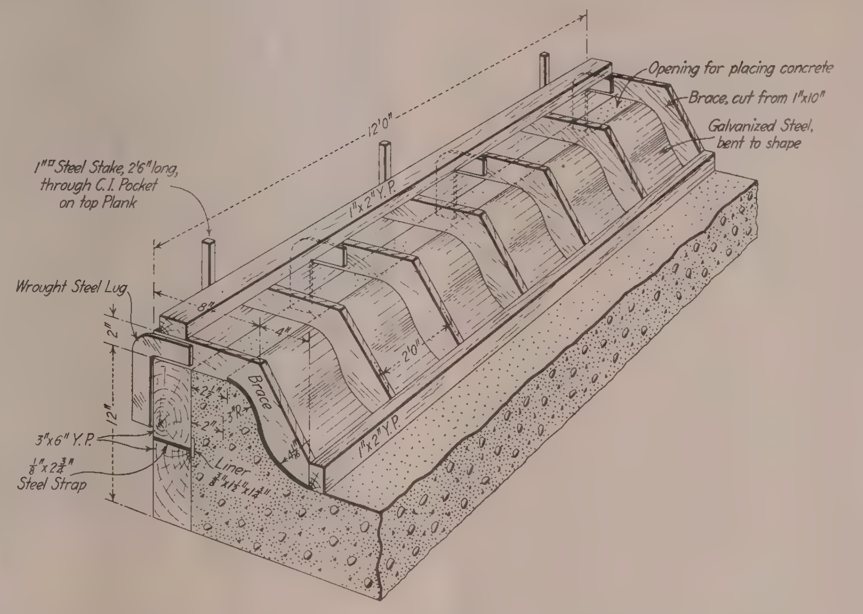
BY MEANS of the long skids shown in the accompanying photographs two 7-ton generators were successfully lowered a long distance down the side of a steep gorge and installed in the power house of Glacier Park Hotel Company, in Glacier National Park, Montana. The generators were hauled by road to a point just above the power plant, and then unloaded and mounted on the skids. Needless to say, after the descent was started no rollers were necessary. There were several ledges in the path, and the skids had to be made long enough to pass over these in safety. Careful snubbing was necessary, but the heavy loads were lowered without accident and in a short time. The turbines were lowered in the same way.

The two units were erected by the writer for the Allis-Chalmers Manufacturing Company.

DOWN THE SIDE OF A STEEP GORGE



SEVEN-TON GENERATOR MOUNTED ON LONG SKIDS FOR ROUGH TRIP DOWN STEEP MOUNTAIN



SIMPLE BUT RIGID FORM INSURES GOOD ALIGNMENT OF INTEGRAL CONCRETE CURB

Simple Integral Curb Form Built with Bent Steel Plates

More than $2.60 per capita was saved to the taxpayers of East Milwaukee, Wis., last year by the use of integral curb on the 80,000 sq. yd. of concrete pavement laid. One of the contractors, the Dean Construction Company, has developed a curb form, an isometric view of which is shown herewith, that worked so well the village engineer has specified its use in the paving to be done this year.

As soon as the pavement is struck off the form is set in place and filled. Any tendency for it to lift when the concrete is poured behind it is overcome by applying convenient weights.

Most of the work in East Milwaukee is of two courses with a base course of 1:2½:4 mixture and a top course of 1:1½:2 granite mixture. That portion of the integral curb extending above the pavement is made of the same mixture as the top course of the pavement. All pavements more than 20 ft. in width are reinforced.

The work is being carried out under the direction of F. W. Ullius, Jr., engineer for the village, which has employed him since 1913.

Time Study Eliminates Costly Details of Design

By DAN PATCH
Aberthaw Construction Company, Boston

TIME STUDY has been applied by the writer in the new use of eliminating unnecessary work by determining features of the plans that entail useless effort and correcting trouble in the office. The average person considers time study as one of the tools of scientific management by which the human machine is to be speeded up. Hence, on the part of workmen, there has grown to be a great distrust of any man in the overhead organization if he pulls a watch from his pocket.

No argument is needed to prove that the average workman, if given proper conditions, will give as honest return for the investment made in him as the average man behind the desk. Both, however, should be interested in the elimination of useless tasks, and in this field time study should find its most fruitful application.

The following application to a simple problem in construction may illustrate the point. Costs were being obtained on the laying of maple floors. These floors were laid on a tar base, all supported by a reinforced-concrete slab. The building was of a modified mushroom type with square columns, the corners of which were chamfered to prevent the breaking down of the columns under fire stresses.

It was noted by the cost department that after a floor had the full quantity reported a considerable amount of time was charged. This was due to the fitting of edge strips along the walls and around the columns. In investigating this item the cost man noted that much time was spent in filling the triangular spaces at the corners of the columns. A time study was made to determine the influence of this on the cost of the floor as a whole. The work of filling these corners was being done as follows:

The carpenter would make his measurements of the opening, for each one was enough different to preclude the use of a standard or jig filling piece, and then lay this triangle out on a piece of scrap maple flooring. He would then saw the piece out, try it in the opening and with his knife make any necessary alterations to complete a fit. This study developed the fact that about 20 cents per square of the floor laid was due to the operations attendant on filling these corners. Instead, however, of trying to speed up the men and reduce the cost, a study was made of the possibility of eliminating the process and hence the item of cost. Two methods presented themselves, one of which reduced the cost by about a half and one of which eliminated the cost. The first was to fill the openings with concrete after the edge strips were laid. The second was more complete and involved the forms.

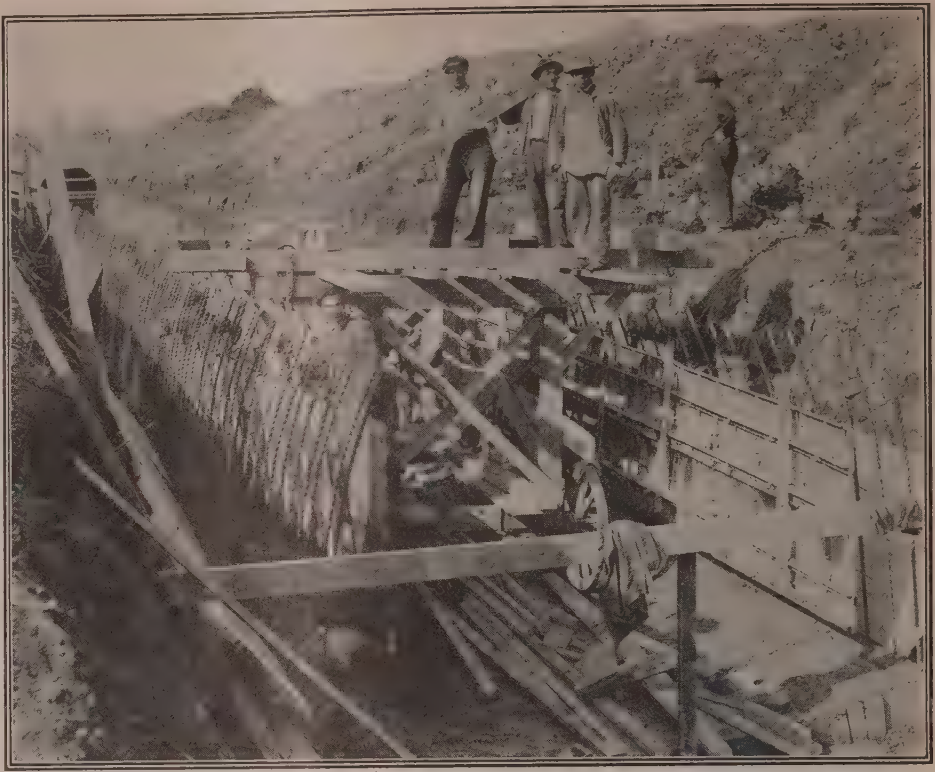
When the column forms were made a fillet was placed on the forms to give the desired chamfer. By cutting this fillet off at a 45-deg. angle about 2 in. above the grade of the edge strips the bottom of the column was poured with square corners. This eliminated not only the cost of fitting corner pieces but saved the operations of sawing the 2-in. spruce plank and maple flooring to fit around the chamfered corners. This may seem a slight item but in the construction of a good-sized factory is well worth saving.

The point is, however, that while there may be justification for antagonism to time study for speeding purposes, there should be none to its use for eliminating unnecessary processes in construction and manufacture.

Wagon, Used as Carriage for Sewer Forms, Rolls on Invert

IN BUILDING the Columbus, Ohio, sewer, the handling of the invert forms on a section of which was described on page 685 of the Engineering Record for May 20, 1916, a special carriage made with wagon wheels was used on the open cut sections to raise and carry the sidewall forms. The wheels of an old wagon were set on 6 x 6-in. axles with 8-ft. gage, and on the axles was built a frame with which 30 ft. of inside or outside forms could be handled. The forms on each side were raised by means of the levers on top of the frame shown in the accompanying photograph, until they cleared the finished walls. The wagon was then pushed ahead by four men. These four men were able to move and set 60 ft. of either inside or outside form in about 3 hours. The arch forms for this part of the work were pulled ahead on a track built on posts resting on the invert. This track was built in sections of 60 ft. each.

The method described was used on the south side storm sewer, which is being built by J. C. Carland & Company, of which Charles E. Cannell is manager and H. R. De Lorme secretary, for the city of Columbus, which is represented on the work by R. C. Chaney, assistant engineer, under W. J. Weaver, engineer in charge of sewer construction, and Henry Maetzel, chief of the city engineering department.


RIG MOVES AND SETS SIXTY FEET OF SIDEWALL FORMS FOR SEWER IN THREE HOURS

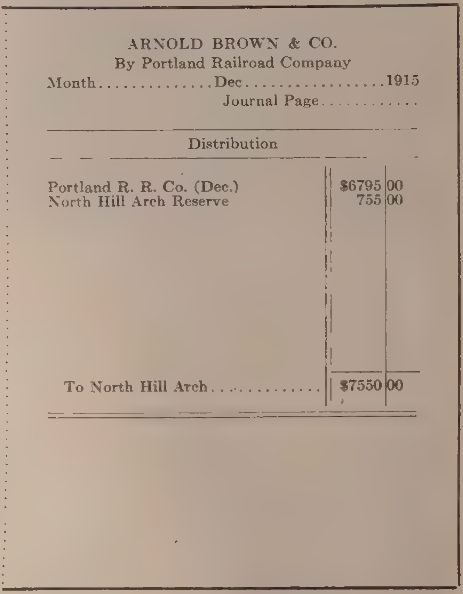
Accounting for the Contractor—Credit Memoranda, Estimates

By BENJAMIN L. LATHROP

Lathrop, Shea & Henwood Company, Scranton, Pa.

CREDIT memoranda should be handled before posting in the journal or ledger by the same method as that described in the second article of the series (page 717, Engineering Record for May 27, 1916) for taking care of invoices, except that the folder to which they are attached should be of different colored paper from those used for invoices, so that the credit memoranda will be readily distinguishable in the files. The form for listing and distributing invoices should be changed to convert it into a form for credit memoranda by substituting "credit" for "invoice" and "by" for "to."

The estimate sheets showing the amount of work allowed for during the month, the percentage retained until completion, etc., which usually accompany monthly payments from the owner to the contractor, should be attached to a credit folder. In this case no entry is necessary on the inside of the folder, but the outside should be filled in as indicated on the accompanying form.


ARNOLD BROWN & CO.
By Portland Railroad Company
Month..............Dec..................1915
Journal Page............

Distribution

Portland R. R. Co. (Dec.)	$6795	00
North Hill Arch Reserve	755	00
To North Hill Arch..............	$7550	00

CREDIT FOLDER LISTING ESTIMATE PAYMENTS

It is a good practice to keep a ledger account with the reserve, or retained percentage, on each job, thus giving the contract full credit for the gross earnings. While this reserve is a nominal or deferred asset, it has a proper place on the ledger and in the balance sheet.

[This is the third of a series of short articles on good accounting methods for contractors. Others will appear in succeeding issues.—EDITOR.]

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Corrosion Causes Failure of South Street Bridge, Philadelphia

End Diagonal Eyebars Break Under Carload of Stone, but I-Beam Chords Prevent More Than 18-In. Sag in Truss

An iron truss 100-ft. span of the bridge carrying South Street, Philadelphia, over the property of the Pennsylvania Railroad near the Schuylkill River failed May 26 due to the breaking of end diagonal eyebars weakened by corrosion. The reserve strength of the I-beam top chords prevented serious consequences and no damage resulted except to the bridge structure, one panel point (L_1) dropping about 18 in. The information which follows has been furnished by Jonathan Jones, assistant engineer of bridges, city of Philadelphia.

This portion of South Street bridge comprises three spans of about 75, 100 and 75 ft. respectively. The central or longest span, the one which failed, does not at the present time span railroad tracks, though there were tracks under it when it was built in 1878. Locomotive gases thus had a share in promoting corrosion, and the pocket formed under the wooden floor at the panel point where failure occurred no doubt held water for considerable periods.

Carried Heavy Traffic

The bridge is 52 ft. wide, the two lines of trusses being 36 ft. center to center. Transverse floorbeams of rolled I-beams trussed with rods support wooden longitudinal stringers and a timber floor. The bridge has been carrying two lines of the heaviest type of electric car in Philadelphia and also heavy trucking traffic, though it is seldom that more than two heavy vehicles are on the same span at one time.

The trusses are of the Pratt type, with counters in all except the two end panels. The top and bottom chords each consist of four I-beams. The web diagonals are eyebars and the posts are of the old Phoenix type. The end top chord I-beams rest on top of the vertical end post, which rests on the end of the bottom chord I-beams, and these on the supporting bent.

Eyebars Rusted Away

The end diagonal eyebars rusted away inside of the bottom chord joint L_1, to a degree which caused them to break under a heavy carload of paving materials. This threw the shear to the two chords, acting as girders, and the bottom chord I-beam L_0L_1, also badly corroded, failed in bending adjacent to L_1. The top chord I-beams, having a greater margin, took the load and though deflecting about 18 in. continued to support the truss and floor.

Traffic was at once diverted and the failed panel point braced and jacked up on a bent of 12 x 12-in. timber. The floor was removed and relaid. Both trusses were then supported by timber bents at all panel points, and it is intended to similarly brace the two 75-ft. spans. Where the railroad tracks beneath interfere with the placing of bents, old girders above deck will be used to relieve the trusses.

With these temporary precautions, traffic will be resumed and the city councils will be asked to appropriate funds for a new bridge to be built during 1917. The old masonry piers and abutments are in excellent shape. A new superstructure will cost about $60,000.

The temporary repairs are being directed by John H. Neeson, assistant engineer, Bureau of Highways, city of Philadelphia, in charge of the maintenance of bridges and sewers.

Naval Board to Head Chicago Engineers' Preparedness Parade

Members of the Naval Consulting Board of Illinois will act as the honorary committee of the engineers' division of the Chicago preparedness parade to-day. The Illinois members of the board are S. K. Copeland, chairman; Dr. W. F. M. Goss, William Hoskins, Robert W. Hunt and Peter Junkersfeld. Bion J. Arnold, member of the National Naval Consulting Board, will also be one of the honorary committee. The volunteer engineers' committee has extended invitations to all companies employing technical men to join the parade.

Invitations have also been extended to all engineering colleges and universities within convenient distances of Chicago and it is expected that delegations from the universities of Illinois, Wisconsin, Michigan and Northwestern and Armour and Lewis institutes will march with the engineers' division.

Among the societies co-operating with the volunteer committee are: Western Society of Engineers, Joint Committee on Military Engineering, American Society of Civil Engineers, Chicago Engineers' Club, Illinois Society of Engineers, Illinois Association of Structural Engineers, American Association of Engineers and Associated Technical Men.

$150,000 Maceo Monument Built by Cuban Engineers in 1½ Months

Largest Work of the Kind Ever Undertaken in Cuba Will Be Exposed to Unbroken Force of Tropical Hurricanes

After 1½ months of night and day work, Cuban engineers completed, unaided by outside advice, the construction of the $150,000 Maceo monument. It is the largest work of its kind ever undertaken on the island. The official unveiling took place on the country's independence day, May 20. The approximately 600-ton monument rests on a concrete foundation carried down to solid rock and each piece is tied in and anchored by bronze or steel.

Foundation 40 Ft. in Diameter

For the foundation earth was excavated to a depth of about 12 ft. to solid rock in a circle 40 ft. in diameter. This hole was filled with concrete mixed in the proportion of 1:2:3, using native cement and ¾-in. reinforcing bars. After the concrete had set 12 days the building of the monument was started.

For the erection a girder crane was set up on timber towers on each side and running longitudinally along them. A trolley along this provided for transverse movements. The heaviest piece set weighed 9 tons.

MACEO MONUMENT IS LARGEST WORK OF ITS KIND UNDERTAKEN IN CUBA

The base consists of an American granite facing with solid concrete filling. The shaft was built of Carrara granite also filled in with concrete. Each piece of granite is securely anchored with bronze tie-bolts.

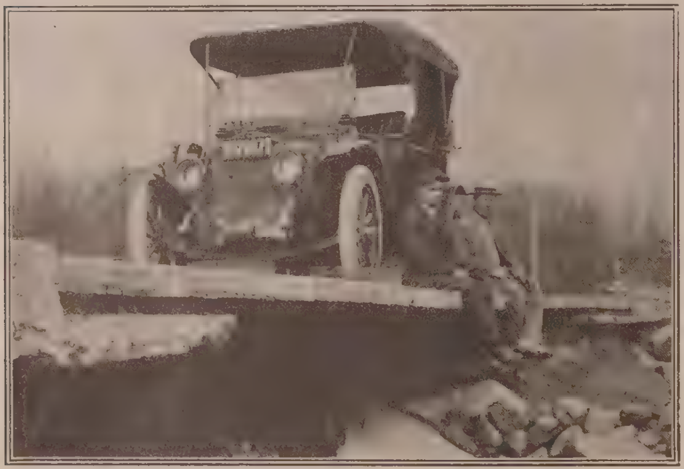
As the monument stands on the seafront, entirely exposed to the hurricanes to which the locality is liable, and the figure on the top is fastened only by the hind legs of the horse, steel rods 2½ in. square were imbedded in each leg and run through the bronze base several inches into the marble slab beneath.

The total cost of the monument, including construction was $150,000. The erection was executed by the National Department of Public Works, of which Col. Jose R. Villalon is secretary, under the immediate direction of Leopoldo G. Abreu. The statue is the work of Dominico Boni, sculptor, of Carrara, Italy.

Brick Pavement Undermined, Yet Upholds Heavy Load

Paving a short distance west of Wooster, Ohio, where the road skirts Killbuck Creek, was undermined this spring and the road inundated for many hours. When the water receded it was found that the embankment supporting the road had been gouged away for several hundred feet by the swift current. For a distance of 60 ft. the concrete base of the pavement was swept away, leaving the brick surface intact.

A strip of the under side of the brick 60 ft. long and 6 ft. wide was scoured clean, yet a good-sized automobile and its passenger were able to rest on the edge. In preparing to refill the wrecked embankment large boulders were dumped upon the pavement and rolled over the protruding edge. This was accomplished without disturbing a single brick. The road will be rebuilt up to the pavement, reversing the customary procedure.



UNDERMINED BRICK PAVEMENT SUPPORTS AUTOMOBILE AND PASSENGERS

The information and photograph were furnished by the National Brick Manufacturers' Association.

8,000,000 Tons of Rain Falls at Rochester First Part of May

According to reports from Rochester, N. Y., the rainfall during the first twenty-three days in May was 4.2 in. Rochester covers nearly 16,000 acres. Hence the amount of water which has fallen on this area during the stated period is approximately 8,000,000 tons.

St. Louis Engineers Will March To-day for Preparedness

Great enthusiasm among the St. Louis engineers has been aroused by Col. J. A. Ockerson and his assistants for the preparedness parade in that city to-day. Every effort has been made to get every engineer in St. Louis to participate.

Leaking Basin at Bellaire, Ohio, Is Repaired with Sheet Rubber Strips

Simple Expedient Proves Successful After Attempts for Eleven Years Fail to Make Reservoir on Unstable Foundation Tight

Rubber strips placed over cracks and boxed in with mud made the reservoir walls of a filter plant at Bellaire, Ohio, watertight and enabled it to be put into successful operation for the first time in eleven years. Built in 1905, at a time when funds available for construction were limited, the plant, because of lack of certain necessary equipment, could not be operated for the first six years. Since that time the source of trouble has been the sedimentation basin, whose insufficient foundation allowed it to settle and crack, defying all attempts to make it watertight until it was recently repaired with rubber sheeting.

An attempt was made to repair the sedimentation basin in 1911. After this work was completed the basin was filled with water, but because it was not built on proper ground it settled still more, and such large cracks appeared that it was again found impossible to operate the plant. In 1913 $4,500 was spent in placing concrete piers 23 ft. below the bottom of the basin and extending them to so-called bedrock. Tie rods were placed diagonally across the basin to support the wall. The bottom of the basin was thoroughly cemented and the interior of the walls was plastered with neat cement mortar. When tested Dec. 29, 1913, the coagulation basin was filled to a point about 4 ft. below the flow line before any deflection or leak occurred. At this point, however, a settlement took place in one corner of the basin, causing cracks in the walls and across the roof. The leakage from the basin was sufficient to erode the bank of the river adjoining the plant, and the water in the basin did not reach a sufficient elevation to provide for the passage of water to the filters. The city officials were discouraged in their attempts to make the plant a success, and the people were thoroughly disgusted. Owing to the poor location and the apparent impossibility of repairing the plant the chief engineer of the State Board of Health reported that it should be abandoned and a new one built in a more favorable location.

Method of Repair

However, in October, 1914, E. J. Lewis, a resident of Bellaire, offered to make the sedimentation tank watertight. Failing to do so he was to receive no pay. His proposition was accepted, and with the expenditure of a very small sum he succeeded in the following manner:

A strip of rubber sheeting 30 ft. long by 3 ft. wide by ⅛ in. thick was placed in the corner of the basin covering the crack. A box was then built around this rubber covering and filled with soft mud. A large crack in the bottom of the basin was also covered with a strip of rubber and was held in place by a cement covering. The basin was then filled with water and it was found that although the crack in the wall opened still further 1/16 in., there was absolutely no leakage.

Under the direction of C. P. Hoover, consulting chemist of Columbus, Ohio, some changes were made in the method of applying the chemicals to the water, and the plant is now in continuous operation. The water is treated with enough lime to absorb the free and half-bound carbon dioxide and from 1 to 1½ gr. of alum per gallon. Mr. Hoover reports that the results have been satisfactory, giving a clear, colorless water free from intestinal bacteria.

Livingston County (N. Y.) Floods Cause Nearly $250,000 Damage

According to estimates made by the superintendent of Livingston County, New York, nearly $250,000 damage has been done in that county by recent floods. Bridges have been wrecked, roads washed out and sluices destroyed.

Two bridges were washed out at Geneseo. Bridges in the town of York will have to be repaired at an estimated cost of $15,000. Nearly forty bridges and sluices as well as many of the roads in the town of Groveland were damaged. Ten bridges were washed out and thirty sluices destroyed at Nunda. Ossian and Portage also suffered considerable damage.

Thirty bridges and sluices at Conesus will have to be rebuilt, while six bridges were badly damaged and several roads washed out at Mount Morris. The Geneseo-Moscow road will be in commission only after an expenditure of several thousands of dollars. Considerable bridge repair and reconstruction will also be necessary at West Sparta, Avon, Livonia, Lima, Springwater and Dansville.

Rebuilding Wrecked Cities Taught by French Government

"The Reconstructed City" is the name of an exposition in Paris, France, which began May 15 and will last four months. The purpose is to instruct the people in the reconstruction of cities destroyed during the war. According to the National Lumber Manufacturers' Association, it is a French exposition entirely. America's lumber manufacturers have, however, sent an exhibit to show the possibilities of American timber in the work of reconstruction.

Different parts of the exposition are devoted to road-building, city planning, city residence construction, city industrial buildings and rural work. In some cases the city-planning department will work for an entire reconstruction, on entirely new lines, of the cities which have been wrecked. In other cases building construction along the old streets only will be required. The road work will be important, as shells have raised havoc with the famous highways of northern France.

Army Engineers to Study Utilization of Great Falls Power

Col. Henry C. Newcomer, Lieut.-Col. C. A. F. Flagler and Lieut.-Col. W. W. Harts comprise the board of engineer officers recently appointed to study and report on the question of utilizing the power of the Great Falls of the Potomac River.

The investigation is being made to determine the adequacy of a power plant at that location to furnish current to meet the growing demands of the federal and district governments. The information will supplement that contained in the Langfitt report.

Bureau of Commerce Reports Latest Foreign Tariff Changes

A report on the latest changes and developments in foreign tariffs has just been issued by the U. S. Bureau of Foreign and Domestic Commerce at Washington. In addition to the usual notices of recent changes, actual and proposed, in import and export duties, customs regulations and internal taxes of foreign countries, the publication contains the more important embargo and contraband provisions, a summary of the regulations affecting commercial travelers in Central America and articles on a number of other subjects more or less intimately connected with foreign tariffs. There is included an article on the probable revival of German commercial influence in Russia after the war. The report is designated "Foreign Tariff Notes, 19," and may be had by application to the Bureau of Foreign and Domestic Commerce or to any of its district offices.

Engineering Society Comes to Aid of Canadian City Engineer

The report under this heading in the issue of May 13 stated that G. W. Craig, city engineer of Calgary, Alberta, had been absolved from all blame for the failure of a reinforced-concrete arch bridge over Bow River. The bridge referred to is now under construction. No failure has occurred and the structure is said to be perfectly safe.

The charges against Mr. Craig concerned the use and testing of re-rolled steel, alleged neglect in not carrying certain foundations deep enough and several minor matters. The committee of members of the Canadian Society of Civil Engineers who made the investigation are of the opinion that the cost of testing the re-rolled steel was not extravagant; that economy warranted the use of such steel in certain parts of the structure, and that the foundations in question had been carried to a sufficient depth. A detailed account will be published in the Engineering Record for next week.

Conservation Congress Indorses Preparedness for Engineers

The Sixth National Conservation Congress recently passed a resolution indorsing and pledging its support to the patriotic work of the engineers and the Committee on Industrial Preparedness of the Naval Consulting Board, and commending their able and patriotic work.

Sprinkler System in Baltimore in Operation

THE IMMENSE SPRINKLING FILTER SHOWN IN THE PICTURE IS A PART OF THE SEWAGE-DISPOSAL SYSTEM INSTALLED AT BALTIMORE. SOME IDEA OF THE VAST AREA DEVOTED TO THIS FILTER MAY BE GAINED FROM THE ILLUSTRATION.

Offer Short Course in Concrete

A practical course in the use of concrete is being offered by the extension division of the Portland Cement Association. The instruction will be given at Lewis Institute, Chicago, June 26 to July 1. It will be conducted by engineers and teachers of national reputation in the cement industry assisted by a force of laboratory experts and artisans. An exhibit of drawings, notebooks, report blanks, course outlines, photographs, tools, forms, equipment and concrete work from various schools will be shown.

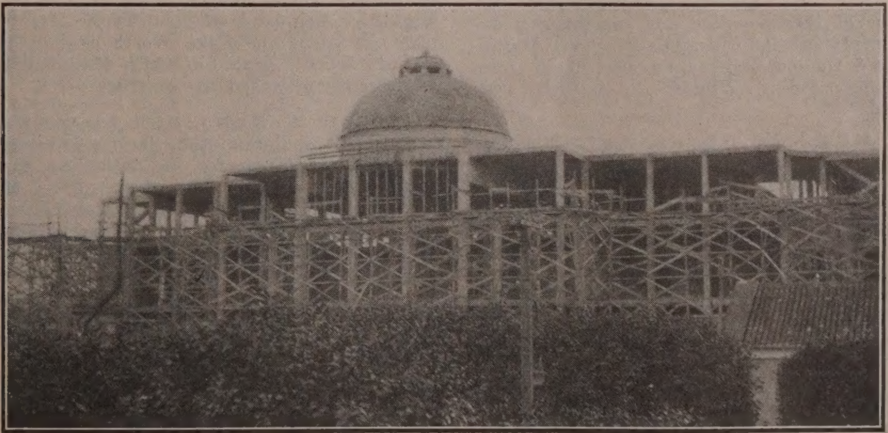
The course is for the benefit of manual training and vocational teachers.

"Jail Might Stop Them—We Can't"

The above is the somewhat startling inscription on one of four luridly colored posters that the Long Island Railroad is distributing in its campaign to educate the public to the danger of disregarding signs, bells and gates at grade crossings. In the poster in question an automobile is racing with a train for a crossing. In a second poster another auto has smashed through lowered gates and is about to meet its fate. A third depicts a horse with a sleeping driver, while the fourth shows a stream of men, women and children "ducking" under the gates.

Must Take Signs Off Bridges

Signs with which country merchants adorn bridges on rural roads in attempts at advertising are under the ban of the state highway commission of Minnesota. State aid will be withheld from all counties failing to cause removal of signs.



May Resume Work on Presidential Palace Abandoned Three Years Ago

WORK ON THE PRESIDENTIAL PALACE AT HAVANA, CUBA, WAS ABANDONED THREE YEARS AGO, DUE, IT IS SAID, TO THE DISCOVERY THAT THE INNER ROOMS WOULD BE WITHOUT LIGHT AND VENTILATION. THE GOVERNMENT IS CONSIDERING AN APPROPRIATION TO REBUILD AND COMPLETE THE STRUCTURE.

Contractors Form Association

The Astoria Builders' Exchange was recently organized in Astoria, Ore. The officers elected are: J. E. Simons, president; J. H. Hansen, vice-president; A. B. Thorsnes, secretary; C. G. Palmberg, treasurer. The organization was formed in the interest of general contractors, builders, etc. Fifty members have already been enrolled.

Engineering Society Activities

The Municipal Engineers of the City of New York have chartered the steamer Mandalay for a dance and moonlight sail up the Hudson River on the evening of June 15.

The Engineers' Society of Western Pennsylvania at the June 6 meeting will hear Thomas P. Roberts, of the U. S. engineer office at Pittsburgh, present a paper on the glacial epoch.

The Southwestern Concrete Association completed its organization at a meeting held May 26 at Kansas City, Mo. A constitution and by-laws were adopted and the following officers, all from that city, were elected: President, G. B. Appo, publisher of *Portland Cement;* vice-presidents, Martin Carroll, general contractor, and W. F. Fague, of the Sunflower Portland Cement Company; secretary, H. H. Peters, manager, *Western Contractor;* treasurer, Charles A. Stevenson, Kansas City manager of the Lansing Company.

What Engineers and Contractors Are Doing

BERNARD J. SWEENEY, superintendent for Morrison & Quinn, engineers and contractors, of Rochester, N. Y., will have charge of the construction of a sewerage system at Oriskany, N. Y. Mr. Sweeney recently had charge of construction of the reservoir and dam at Le Roy, N. Y. He was also in charge of the construction of storm sewers and the regulation of the flow of Dry River at Watervliet, N. Y., at which time he was connected with the firm of Leary & Morrison. The work at Watervliet was described in the Engineering Record of Nov. 21, 1914, page 571. Two years ago Mr. Sweeney had charge of the Densmore Creek storm sewers at Rochester.

H. A. STRINGFELLOW, consulting engineer, of Rochester, has been made consulting engineer for the Sedgwick Machine Works, of New York City. He will work on the design and construction of elevators and hoisting machinery.

R. M. BURKHALTER was recently appointed resident engineer in charge of the construction of one of the East River tunnels of New York City's dual subway system. Mr. Burkhalter was employed on the construction of the Pennsylvania Railroad East River tunnels, the Washington Street tunnel at Chicago and the Yonkers (N. Y.) pressure tunnel of the Catskill aqueduct. He resigned as superintendent of the Alabama Power Company to accept his recent appointment with the Public Service Commission.

Frank R. Fisher, who was employed on the construction of the Market Street subway in Philadelphia, has been made engineer in charge of construction of the section of the Broad Street subway beneath the City Hall in that city. Mr. Fisher, who is a graduate of Lehigh University, has been active in engineering work in Philadelphia for a number of years.

William von Phul will succeed Charles N. Blake as vice-president of the United Railways of San Francisco. Mr. von Phul was graduated from Tulane University in 1892. He has since been actively engaged in many power-plant constructions and from 1907 until 1912 was engineer in charge of operation and construction for several Southern light and power companies and electric lines. He is also vice-president of the American Cities Company.

J. L. Jacobs, consulting engineer, of Chicago, formerly with the efficiency division of the Chicago Civil Service Commission, has been employed by the City Liquor Commission to analyze statistics collected by the police on the material and moral sides of the saloon problem.

Walter J. Parsons, who has been assistant engineer on the erection of the Hell Gate bridge for the American Bridge Company for the past 3½ years, has been made assistant manager of the Pittsburgh office of the Foundation Company.

Thomas Fraher has resigned as superintendent of construction for the Pittsford Power Company at Chittenden, Vt., to become engineer for the Long Leaf Pine Company, of New York City. Mr. Fraher was recently connected with Jacobs & Davies, consulting engineers, of New York City, on the North River tunnel of the Pennsylvania Railroad. Previous to that he worked on the Astoria gas tunnel, and the Mexican Light & Power Company's hydraulic development at Necaxa, Mexico.

Frank Adams, formerly connected with the U. S. Department of Agriculture, has been made professor of irrigation investigations at the University of California.

Howard S. Morse, formerly director of the Cincinnati Bureau of Municipal Research, has been placed in charge of the public works department of the newly organized Detroit Bureau of Governmental Research. The Detroit bureau is a private organization intended to conduct municipal investigations in Detroit and research studies of state and national problems. Mr. Morse was graduated from the Massachusetts Institute of Technology in 1903. He entered the U. S. Reclamation Service in 1904 and was engaged on the Lower Yellowstone irrigation project until 1908, when he became connected with the commissioners of sewerage of Louisville, Ky. In 1912 he was made engineer in charge of the division of sewerage investigation of Cincinnati. Two years later he was made engineer for the Ohio State Institute for Public Efficiency and in 1915 he was elected a director of the Cincinnati Bureau of Municipal Research.

Harold J. M. Baker, junior engineer in the U. S. engineer's office at Seattle, left May 22 for Dry Strait, Alaska, to make a survey of that channel with the object of making it navigable.

Alexander P. Crary, formerly junior engineer for the Isthmian Canal Commission, has been made resident engineer for the Cleveland Dock Engineering Company, of Cleveland. He is now engaged on the construction of a reinforced-concrete wharf and pier at Baltimore. Mr. Crary was graduated from Rensselaer Polytechnic Institute in 1901, after which he entered the employ of the Pittsburgh Railways Company as rodman. In 1902 he became connected with the Wilson & Baillie Manufacturing Company. While with that organization he was engaged on subway work in Brooklyn for the Long Island Railroad. He resigned in 1905 to work for Charles Cranford on depression and elevation of tracks of the Brighton Beach Railroad in Brooklyn. He was made draftsman for the Degnon Construction Company, of New York City, in 1906 and later became associated with Baillie & Dumary, of Guild, Tenn. He was made a junior engineer for the Isthmian Canal Commission in 1908.

D. L. Sommerville, formerly superintendent of the Adirondack division of the New York Central Railroad, has been made superintendent of the St. Lawrence division at Watertown, N. Y. Mr. Sommerville has been in the employ of the New York Central since 1899, when he was made supervisor of bridges and buildings on the Pennsylvania division. He was successively engineer of the Rome, Watertown & Ogdensburg, the Pennsylvania and the Western divisions. He was made superintendent of the Adirondack division in 1912.

M. J. Coffey, general superintendent of the T. A. Gillespie Company, will have charge of the pipe job at Rochester for which his company recently secured the contract. Mr. Coffey has been with the Gillespie company for many years and had charge of the work that company did on the New York State Barge Canal and the New York City aqueduct.

Frank A. Walton has left the employ of the Mississippi River Commission to become connected with the Michigan highway department, with headquarters at Lansing.

John J. Lydon, who has been connected with Westinghouse Church Kerr & Company for twenty-five years, will have charge of the work to be done for the Chicago, Burlington & Quincy Railroad at West Burlington, Iowa. Mr. Lydon recently handled the work for the Aetna Explosives Company at Drummondville, Canada, and for the Taylor-Wharton Iron & Steel Company at Easton, Pa.

William V. Murray recently resigned as superintendent of construction for the State of Montana to become superintendent of construction for James Stewart & Company, of New York City, with headquarters at Bridgeport, Conn.

James T. Clark, vice-president in charge of the operation and construction departments of the Chicago, St. Paul, Minneapolis & Omaha Railway, has been made president, succeeding William A. Gardner, deceased.

Edmund M. Blake, whose appointment as engineer for the Holbrook, Cabot & Rollins Corporation was noted in these columns in the issue of May 20, was educated at Amherst College and Harvard University. He was assistant engineer for the New York Rapid Transit Commission from 1900 to 1902. In the latter year he was made principal assistant to Percy M. Blake, consulting engineer, of Newton, Mass. He resigned four years later and for two years he and H. A. Symonds practised consulting engineering in Boston. In 1908 Mr. Blake became manager of the Idaho Irrigation Company, but again took up private practice in 1909 at Boise, Idaho. He came East in 1911 to take charge of the improvement of the Neponset River for the Massachusetts Department of Health, where he was employed at the time of his recent change. Mr. Blake was president of the Westford (Mass.) Water Company in 1907 and 1908 and was honorary commissioner to Italy for the U. S. Department of Agriculture in 1905, when a report was prepared on drainage and irrigation southwest of Venice.

Ernest L. Merrill has resigned as engineer in the U. S. Department of Agriculture to become engineer for the Maine highway department.

Theodore C. Rogers has won the undergraduate Fuertes medal at Cornell University. The presentation will take place at commencement.

Clement E. Chase, a graduate of Cornell University, class of 1910, was awarded the graduate Fuertes medal for his paper on the Cherry Street bridge at Toledo.

C. B. Brady, formerly junior civil engineer in the roadway department of the Interstate Commerce Commission, has been made deputy collector of United States internal revenue at Austin, Tex.

R. M. Hosea, consulting engineer, of Pueblo, Col., is now engaged on coal-mine valuation work at Denver. Mr. Hosea resigned in 1915 as chief engineer of the Colorado Fuel & Iron Company, the Colorado & Wyoming Refining Company and the Crystal River Railroad. He has since acted as consulting engineer for these companies in addition to his other practice.

J. L. Jacks, Southern manager for James Stewart & Company, is now located at Norfolk, Va., where he is erecting two large warehouse piers and 10,000 ft. of bulkhead, as well as directing dredging amounting to 1,500,000 cu. yd. The work is being done for the Norfolk & Western Railway.

J. B. Ferguson has been elected chief engineer of the Hagerstown (Md.) sewerage committee to prepare plans for a new sewerage system.

Richard H. Aishton, vice-president of the Chicago & North Western Railway, was elected president of that road May 23. He began his railroad career in the engineering department in 1878 as axman. He was consecutively rodman, levelman, assistant engineer, superintendent of bridges and buildings and division engineer. He was made division superintendent in 1897 and general superintendent two years later. In 1902 he became general manager and was made vice-president in 1910.

J. E. Hammond has been transferred from the Marietta division of the Pennsylvania lines west of Pittsburgh to a more responsible position on the Toledo division.

J. C. Mitchell, who is now employed on construction at Dallas, Tex., for the Lock Joint Pipe Company, of New York City, will have charge of the Lake Worth conduit job at Fort Worth, Tex., for which his company was recently awarded the contract.

George H. Reussner has resigned from the U. S. Reclamation Service to become construction engineer for the Bethlehem Steel Company, at South Bethlehem, Pa. Mr. Reussner was graduated from Lehigh University in 1911, after which he spent a year in the bridge department of the Lehigh Valley Railroad. He joined the U. S. Reclamation Service in 1912 and was made junior engineer on the Milk River project in 1913, where he was engaged at the time of his resignation.

Karl C. Kastberg has severed his connection with the engineering and water departments of Boone, Iowa, to become city engineer of Des Moines.

Robert McCormick succeeds Karl C. Kastberg as city engineer of Boone, Iowa.

E. S. Walker is engaged in making a topographic survey of a military reservation near Cordova, Alaska, for the U. S. Coast and Geodetic Survey.

E. B. RHINE, formerly connected with the California Highway Commission, has been made junior civil engineer for the Interstate Commerce Commission, Division of Valuation, at San Francisco. Mr. Rhine was engaged as rodman on maintenance-of-way for the Chicago & North Western Railway at Boone, Iowa, from 1909 to 1911. He was later made instrumentman on construction at Sparta, Wis. In 1912 he was appointed resident engineer for the California Highway Commission, at San Francisco. He resigned in 1913 to take charge of highway and bridge construction for San Mateo county, California. He returned to the California Highway Commission in 1914, where he remained until his recent appointment.

E. C. OATES has resigned as manager for the Jackson-Vreeland Investment Company, of Kansas City, to become chief engineer and land commissioner for the Mardez Lumber Company, with headquarters at Benford, Tex.

H. O. KELLEY has been promoted from the position of assistant engineer for the Evansville & Indianapolis Railroad to that of division engineer, with headquarters at Terre Haute, Ind. Mr. Kelley will have jurisdiction over the location and construction of track, buildings and bridges.

T. HICKEY, formerly roadmaster for the Michigan Central Railroad, at St. Thomas, Ark., has been made superintendent of track, in charge of maintenance, with headquarters at Detroit.

PHILLIP D. LAIRD, who resigned from the Maryland Public Service Commission about a year ago, will again become a member of that commission June 1.

ALBERT L. SOLLEDER has left the employ of the U. S. government at Wheeling W. Va., where he has been stationed for the past three years, to become connected with the Dravo Contracting Company, of Pittsburgh.

THOMAS R. TETLEY, JR., consulting engineer, of Brooklyn, has been appointed resident engineer in charge of construction of the Seneca Power Corporation's power plant at Seneca Falls, N. Y.

HARRY W. COLE, a recent graduate of Dartmouth College, has entered the employ of the estimating department of the Petroleum Iron Works Company at Sharon, Pa.

RALPH ST. LAWRENCE PEVERLEY, consulting and constructing engineer, of San Juan, P. R., has given up his practice to engage in commercial business in New York City.

EMIL DIEBITSCH, engineer and contractor, of New York City, was recently elected mayor of the town of Nutley, N. J. Mr. Diebitsch accepted the nomination because of a petition signed by more than 400 citizens, who expressed the opinion that his experience as an engineer and constructor would be of great value to the town. Mr. Diebitsch is a graduate of Lehigh University and ex-president of the General Contractors' Association. During the past twenty-five years he has been connected with many large construction operations, which include a timber drydock at Port Royal, S. C., and a similar structure of granite at Portsmouth, N. H., as well as many of New York's largest buildings.

J. C. ALLISON, formerly chief engineer and assistant general manager of the California Development Company, will open offices for general engineering practice in the Anderson Building, Calexico, Cal., June 1. Mr. Allison will specialize in irrigation, drainage, silt investigation, municipal engineering and valuations. As noted in a previous issue, Mr. Allison has been engaged to make investigations of silt carried by canals from the lower Colorado River with the object of eliminating injuries caused by the silt.

O. A. GEIRLICH has been appointed city engineer of El Monte, Cal., to succeed Robert L. Wood, who resigned recently.

S. H. FINLEY has been appointed city engineer of Seal Beach, Cal. For a number of years Mr. Finley was highway engineer of Orange County, California, at Santa Ana.

G. E. HILL, who has been deputy city engineer of South Pasadena, Cal., for the last few years, has been made city engineer.

W. C. WATTLES has been appointed city engineer of Tropico, Cal.

HAROLD BARGEMAN, county engineer of Maricopa County, Arizona, has been elected secretary and treasurer of the Arizona Association of Highway Engineers, succeeding W. H. Carruthers, resigned. The annual meeting of the association will be held in Phoenix next December.

H. L. CORY was recently made city engineer of Baker, Mont.

J. E. CARMICHAEL, formerly construction foreman for the Montague-O'Reilly Company, of Portland, Ore., has become connected with A. Guthrie & Company, of Portland, in a similar capacity. He will be engaged on the lining of the tunnel of the Oregon-Washington Railroad & Navigation Company at Portland.

HAROLD T. BURGESS has resigned from his position in the engineering department of the city of Meriden, Conn., to become connected with the C. W. Blakeslee Company, contractors, of New Haven. Mr. Burgess is a graduate of Tufts College.

C. C. FLETCHER has been appointed commissioner of waterworks and sewerage at Aberdeen, S. D.

ROBERT BATHMAN, employed by the New York highway department, has been transferred to Elmira.

J. A. LEICHTER will have charge of the construction of a sewage-disposal works on Westerlo Island, near Albany, N. Y., the contract for which was recently secured by the Peter Keeler Building Company of Albany Mr. Leichter has been associated with various construction work, including the foundations and intake for the Riverside power plant, Albany, and work at various institutions.

CLYDE POTTS, consulting engineer, of New York City, has been retained to design a sewerage system for Monroe, N. Y.

ZANE HOFFMAN, formery registrar in the survey bureau of Philadelphia, has been promoted to the position of special inspector.

WILLIAM W. HILL succeeds Z. Hoffman as registrar in the survey bureau of Philadelphia.

JOHN E. ALLEN was recently made assistant engineer of sewer design for Philadelphia, succeeding Charles Frommer, promoted.

CHARLES FROMMER, formerly engineer of sewer design for the city of Philadelphia, has been made assistant to the chief engineer.

GUSTAV J. REQUARDT, division engineer of the Baltimore Sewerage Commission, has been appointed head of the department of franchises and privileges of that city. He will make a complete survey for the purpose of listing all the franchises and privileges with the object of increasing the city's revenue. Mr. Requardt has been connected wtih the sewerage commission since 1909.

LAURENT TONNELLE, of Bayonne, N. J., has been made president of the North Jersey Water Supply Commission. This body, as noted in the May 13 issue, will have charge of the construction of the reservoir at Wanaque, N. J.

JOHN W. HERBERT, of Helmetta, has been elected president of the commission named by Governor Fielder, of New Jersey, to investigate road conditions in that state. The next meeting will be held in Trenton, June 1.

Obituary Notes

JAMES J. HILL, ex-chairman of the Great Northern Railway and one of the most prominent railroad men in the country, died at his home in St. Paul May 29. Mr. Hill leaves many thousands of miles of railroad as his monument. He was born in 1838 in the County of Wellington, Ontario. His first work was in steamboat offices in St. Paul from 1856 to 1865. He later established and became head of the transportation company known as Hill, Griggs & Company. He entered railway service in 1866 as local agent for the St. Paul & Pacific Railroad. That road was reorganized about 1881 and made a part of the St. Paul, Minneapolis & Manitoba Railway, of which Mr. Hill was made vice-president and general manager. He was elected president of that road in 1883, in which position he remained until 1891. He became president of the Great Northern Railway in 1889 and was made chairman of the board of directors in 1907. He resigned as chairman of the board of directors of the Great Northern in 1912, but retained his membership in the board.

JAMES V. ROCKWELL, civil engineer at the U. S. Navy aeronautic station at Pensacola, Fla., was killed May 24 when the aeroplane in which he was flying failed. Mr. Rockwell was previously in the navy service from 1898 to 1899. He resigned to enter the engineering department of the Chicago & North Western Railway, where he remained until 1903. He again joined the U. S. Navy Department in 1903, since which time he had been active in engineering work at San Juan, P. R. He was also in charge of about $2,000,000 worth of work at the Mare Island (Cal.) navy yard. He was recently transferred to Pensacola, Fla.

JOHN PLATZ, contractor, who for more than half a century had been connected with the architectural advancement of South Bend, Ind., recently died in that city. He was born in New Berlin, Pa., in 1827. Mr. Platz came to South Bend in 1851. He erected two paper mills in that city and several of the buildings of the Studebaker and Singer corporations.

HAMILTON FLOOD, civil engineer and contractor, of Quincy, Mass., died May 23 in that city. He was born there forty-six years ago and served as city engineer from 1902 to 1908. Since the latter date he had been in private practice.

FRED T. PERRIS, retired railroad construction engineer of Southern California, died recently at his home in San Bernardino at the age of 79. Mr. Perris was active in the construction of the first lines of the Atchison, Topeka & Santa Fé Railway in southern California. Prior to his connection with the Santa Fé he was in charge of the engineering department of the old California Southern Railway on the construction of its lines out of Los Angeles and San Bernardino. He ran the line and supervised the construction of the San Bernardino-Barstow section. At one time he was county surveyor of San Bernardino County.

Civil Service Examinations

United States: The U. S. Civil Service Commission announces an examination for assistant sanitary engineer to be held July 5 at the regular places. Salary $1,600. Apply for form 1312.

Examinations Previously Announced

Date		See Eng. Record
June 3.	Assistant electrical engineer, New York State	May 13
June 7.	Aid in U. S. Coast and Geodetic Survey	May 20
Aug. 21-25.	Second lieutenant, civilian candidates	April 1

146 Road Rollers Bought by Russian Government

What is said to be the largest single order for road rollers was recently placed by the Russian Government with the Austin Manufacturing Company, of Chicago. One hundred and forty-six Austin motor road rollers were purchased.

American-Made Mastic Takes Place of Imported Product

For a long time many tons of rock mastic were imported from Germany, and in lesser quantities from Switzerland and Italy. When importations suddenly ceased it was discovered that in the Trinidad lake asphalt, which is the bitumen used in American-made mastic, nature has supplied the fine material content, or filler, required.

Thus the war, according to the Barber Asphalt Paving Company, has developed an important specialized industry that not only gives employment to many but is keeping at home a great deal of money that formerly went to foreign producers.

Western Engineer Designs New Rapid Computer

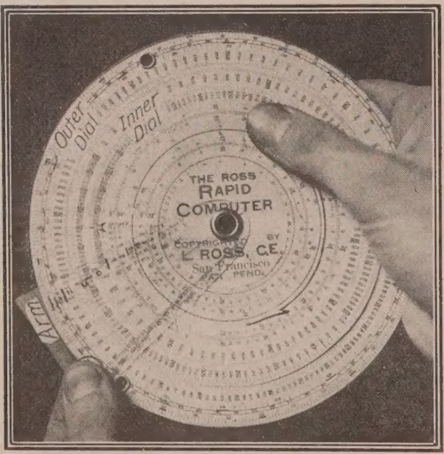
A rapid computer devised to handle a wider range of problems than the ordinary slide-rule has been patented by Louis Ross, civil engineer, of San Francisco, Cal.

Beginning with the outermost, the scales on the outside dial are:

1. Degrees, 0 to 360 deg., for measuring angles.
2. Radians, 0 to 6.283, for circular measure.
3. A scale of equal parts, 0 to 1000, to read logarithms.
4. Scale N, for setting the first number and reading the answer.

The scales on the inner dial are:

5. Scale M, like scale N, but numbered in the reverse direction, to set multiplier.
6. Scale D, like scale N, to set divisor.
7. Sines and cosecants, 6 to 90 deg.; cosines and secants, 0 to 84 deg.
8. Sines and cosecants, tangents and cotangents, 37 min. to 6 deg. Cosines and secants, tangents and cotangents, 84 deg. to 89 deg. 23 min.
9. Tangents and cotangents, 6 to 84 deg.



COMPUTER SAID TO BE QUICKER THAN SLIDE-RULE

10. A scale of squares.
11. A scale of cubes.

The circular form of the computer is said to reduce the number of movements, simplify the operation, prove the answers and afford a full set of reciprocals and equivalent ratios without ever running off the scale. The answer is shown by a big pointer so marked. A smaller auxiliary arrow proves the answer. The conventional method of graduations has been dropped and a simple system of three and four-figure numbers adopted. Numbers can be read to three or four places. The trigonometric scales are claimed to be as complete as a printed table, and can be used directly for figuring areas, volumes, traverses and for railroad curves. The device is sold by the Computer Manufacturing Company, 24 California Street, San Francisco.

30 Trucks Sent to U. S. Troops on Mexican Border

An order for thirty 3-ton Riker trucks was recently placed with the Locomobile Company of America by the U. S. government. The order was placed on a Monday morning, and completely filled Tuesday afternoon. The trucks, accompanied by forty-one mechanics and drivers, were loaded on a special train in the Erie Railroad yards at Jersey City, N. J., and shipped to San Antonio, Tex. The Riker motor truck, in a recent demonstration, ran from Columbus, N. M., to El Paso, Tex., a distance of 93 miles, over the rails of the El Paso & Southwestern system at an average speed of 19 miles per hour. The truck carried twenty soldiers with their complete equipment. On arrival at El Paso it was derailed and driven up the main street, where General Scott inspected it.

FLANGED RIM DEVICE PERMITS TRAVEL ON TRACK OR ROAD

Business Notes

The Des Moines Refining Company has opened a sales office in Des Moines, Iowa, to handle the distribution of its water-softening apparatus.

Theo. Raun, Seattle representative for the Automatic Concrete Mixer Company, has removed his office to the Stuart Building. The firm is now known as the Raun Engineering & Equipment Company.

The Cement Products Exhibition Company recently held an annual meeting at which the following officers were elected: President, B. F. Affleck; vice-president, A. Y. Gowen; secretary, Blaine S. Smith; treasurer, J. U. C. McDaniel.

The Central Foundry Company, of New York City, announces that C. C. Todd, who for many years has represented the company in the West and was elected a vice-president of the company about a year ago, will open a Chicago office July 1.

C. T. Anderson, who has been in charge of the sale of rail bonds and third-rail insulators for the Ohio Brass Company, of Mansfield, Ohio, has resigned to become vice-president and sales manager of the Hartman Electrical Manufacturing Company, of the same city.

Fairbanks, Morse & Company, of Chicago, held the annual meeting of the directors May 17. The following officers were elected: Chairman of the board, C. H. Morse, Sr.; president, C. H. Morse, Jr.; vice-presidents, W. E. Miller, H. C. McClary and H. J. Fuller; secretary and treasurer, F. M. Boughey; assistant treasurer, B. E. Cremerius; assistant secretary, C. A. Meyer.

Stanley H. Rose, until recently in charge of the New York office of the Bureau of Foreign and Domestic Commerce, has been engaged by the Barber Asphalt Paving Company to direct its foreign trade department. Prior to his appointment as commercial agent of the bureau Mr. Rose had an extensive business experience in Europe, Australia, New Zealand, India and Egypt. He has also held important posts with American and European firms engaged in foreign trade. As special agent of the Bureau of Foreign and Domestic Commerce Mr. Rose has just completed a tour of more than fifty cities of the Middle West, South and Southwest, acquainting manufacturers with foreign trade opportunities and advising commercial organizations as to the best methods of promoting export trade. Mr. Rose was educated in London, Berlin, Paris and Brussels and speaks most of the modern languages. The Barber company's export trade in paving materials, roofing and other asphaltic products will hereafter be in Mr. Rose's charge, with headquarters in Philadelphia and New York.

Charles L. D. Conklin, until recently president of the Digger Machinery Company, has severed his connection with that concern and is now with the John F. Allen Company, of New York City, as superintendent of the contractors' machinery department.

G. S. Kelley, formerly with the Digger Machinery Company, has recently been appointed sales representative of the John F. Allen Company, of New York City, in connection with the new department established for the manufacture of coal-handling and hoisting machinery.

Trade Publications

The following companies have recently issued trade publications:

Spray Engineering Company, Boston. Booklet, 6 x 4 in., 16 pages. A list of this company's cooling-pond and air-washer installations, completed or in progress March, 1916. Includes thirty-five cooling-pond installations in numerous states and in Canada, Mexico, Cuba and South Africa. Air-washer installations in twenty-one states are described.

Insley Manufacturing Company, Indianapolis. Catalog 41, 6 x 9 in., 64 pages, illustrated. Describes the Insley gravity plant for concrete distribution and the buckets, cars, skips, and other equipment manufactured by this company.

O. K. Clutch & Machinery Company, Columbia, Pa. Catalog 12, 6 x 9 in., 16 pages, illustrated. Presents a complete line of O. K. hoisting apparatus adapted for operation with gasoline, oil and steam engines or with electric power.